INTERNAL REPORT

Habitat Mapping in the Kent Group of Islands

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Summary

The Kent Group of islands are situated in the middle of eastern Bass Strait and consists of Deal, Dover, Erith, North East and South West Islands, as well as various small rocky islets. The island group is in the Twofold Shelf Bioregion and represents the only location for this bioregion in Tasmanian waters. This report details the spatial distribution of seabed habitat types in the Kent Group of islands out to the 3 nautical mile (Nm) limit. Habitat boundaries were logged in the field using a combination of echosounder and video analysis of the seabed, with the video also used to identify the dominant macroalgae and seagrass present. Habitats were defined at two hierarchical levels, with the higher level categories being rocky reef, unconsolidated vegetated and unconsolidated unvegetated substrate.

The Kent Group of islands has a diverse range of habitats reflecting the regions bathymetry, oceanography and geomorphology; including rocky reefs of varying exposure and depth, sheltered coves with seagrass, and extensive areas of sponge and sand habitat. The island group is dominated by hard sand and sparse sponge habitat that combined make up around 87% of the total area. However, the distribution and extent of habitat clearly varies by depth, with shallow waters (0-20 m) dominated by reef (mostly low and medium profile) with lesser amount of sand and seagrass. The mid depth range (20-40 m) still contains significant areas of low and medium profile reef although an increasing proportion of hard sand habitat occurs in the deeper parts of this strata. Over 40 m the habitats are predominantly hard sand and sponge.

Reefs on the exposed coasts are typically dominanted by the macroalgae *Phyllospora comosa*, which extends from the immediate subtidal zone to depths of 10 to 20 m where it is gradually replaced by *Ecklonia radiata.* However, within the sheltered embayments *E. radiata* and *Cystophora monilifera* replaces *P. comosa* as the dominant algae. Murray Pass is an area of particularly high habitat diversity due to the presence of deep water and strong currents providing a suitable environment for sponge habitat in depths >40 m, rocky reefs with varying depth and exposure and several sheltered coves with seagrass and shallow sand. Seagrass beds consist of single or mixed beds of *Halophila australis, Heterozostera tasmanica* and *Posidonia australis* with variations in species composition, patchiness and percentage cover evident within and between coves.

Sponge habitat, defined as sparse and dense based on the acoustic reflectance and percentage cover from video analysis, covers around 40% of habitats in depths >40 m. Sparse sponge consisted primarily of sand interspersed with small clumps of low sponge while dense sponge was on a more consolidated substrate with a higher relief and had a high sponge cover of encrusting, erect and branching forms. The ascidian *Pyura* sp. and many species of octocorals, soft corals, anemones and bryzoans were also present.

Sixteen 1:10,000 scale maps of seabed habitat of the Kent Group of islands are presented that can be used, in combination with previous quantitative surveys of flora and fauna, to assist with the planning process for a Marine Protected Area in the region.

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1. Introduction

The Kent Group of islands are situated in the middle of eastern Bass Strait, between the northern tip of Flinders Island and Wilsons Promontory and consists of five islands, Deal, Dover, Erith, North East Island and South West Island, as well as various small rocky islets (Fig. 1). The islands are granitic and are part of a batholith of granite of Devonian origin which extends from the Victorian coast to as far south as Maria Island in eastern Tasmania. The topography of the shoreline consists primarily of steep cliffs that continue underwater, often to depths of around 50 m where it ends in sand. There are also several shallow coves around the outer coast and in Murray Pass between Deal and Erith Islands.

The weather in the region is dominated by winds from the west and south-west and can be persistently strong for extended periods, particularly during winter and spring. While these winds influence water flow and sea state at the local-scale, they are also responsible for driving currents at the meso-scale, particularly nutrient-poor eastward flowing Bass Strait water which dominates the region in winter. In late spring and summer a mix of warm, nutrient-poor East Australian Current water and small amounts of cool nutrient-rich sub-Antarctic water dominates the region. The amount of sub-Antarctic water present is likely to show considerable interannual variability due to the varying dominance of EAC water in the region.

Overall, the nutrient levels are generally low in the area due to the lack of coastal influence and the dominance of nutrient-poor water masses. The exception is when sub-Antarctic water sporadically flows into eastern Bass Strait, which is often greatest during late winter and spring (Bax and Williams, 2000). Water temperatures generally range from around 17^{o}C in summer to 11^{o}C in late winter/spring reflecting the seasonal influence of meso-scale currents and solar warming. The tides in the region are semi-diurnal and have a range of around 2.0 m.

The Kent Group is located at the convergence of the Peronian, Maugean and Flindersian marine biogeographic provinces. While the marine plant assemblage consists of species with a widespread distribution throughout southern Australia, the fauna is notably influenced by Peronian (New South Wales) species. The faunal diversity is high due to the convergence of these three biogeographic regions (Edgar, 1984) and enhanced by a wide range of habitats, degrees of exposure and meso-scale currents (Edgar, 1984). Information on the diversity of fish and benthic flora and fauna collected from earlier surveys has recently been detailed in RPDC (2002). The surveys describe the faunal and floral composition of the Kent Group based on dive surveys of a limited number of sites.

The Kent Group is in the Twofold Shelf Bioregion and represents the only location for this bioregion in Tasmanian waters (Fig. 1). The bioregion extends from just south of the Kent Group and up the New South Wales coast to Tathra. Islands to the south of the Kent Group are included within the Flinders bioregion due to their different fish and invertebrate communities (Edgar, 1984) which lack the strong Peronian influence found at the Kent Group. In contrast, the seaweeds of the Kent Group are not distinct from other north-east Bass Strait islands (Edgar *et al*., 1997) and all but a few are widespread around northern Tasmania (Barrett and Edgar, 1992).

This report details the results of a cruise in August 2002 that conducted detailed mapping of seabed habitats in waters of the Kent Group of islands in eastern Bass Strait. The report only considers the waters around Erith, North East, Dover and Deal Islands out to the 3 nautical mile (Nm) limit. The Tasmanian Government appointed the Resource Planning and Development Commission (RPDC) to conduct an identification and selection process for Marine Protected Areas (MPAs) in the State. One of their primary tasks is to undertake a shortened assessment process for a newly proposed MPA in the Kent Group. The scope of the inquiry includes an assessment of the use of the identification and selection criteria contained within the Tasmanian Marine Protected Areas Strategy to assess whether the areas of public land under investigation in the Kent Group are suitable as a potential MPA. The inquiry will also identify possible arrangements for management, including potential boundaries.

A background report was produced that provided a description of the Kent Group including current management arrangements, a description of the marine environment including the bathymetry, seabed habitats and marine flora and fauna (RPDC, 2002). There was also a summary of the aspects of the human use of the marine environment in the region. Much of this report was summarised from earlier surveys of the Kent Group by Edgar (1984) and Barrett and Edgar (1992) which were conducted to assist in the assessment of reef community composition and were structured to survey specific sites and assemblage composition. These surveys did not provide spatial maps of habitat distributions for the Kent Group of islands, the detailing of which here will add considerably to the quantitative surveys of flora and fauns previously conducted. Therefore, the overall objective of this report is to detail the distribution of seabed habitats in the vicinity of the Kent Group of islands, eastern Bass Strait out to the 3 Nm limit and broadly describe the dominant macroalgae and seagrass associated with these habitats.

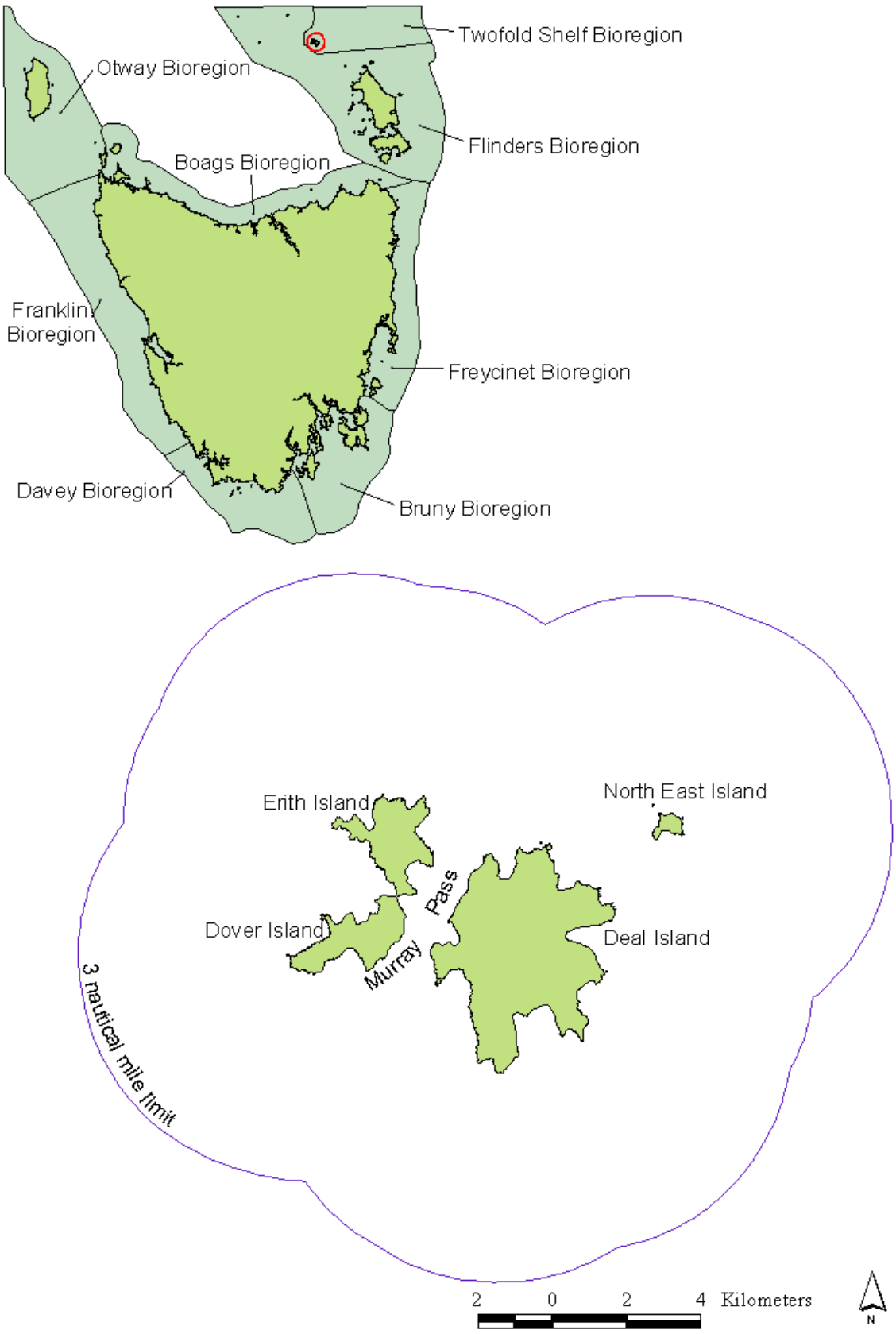

Fig. 1. Distribution of Tasmanian bioregions and the Kent Group of islands in eastern Bass Strait

2. Methods

2.1 Field mapping

Benthic habitat type and boundaries from 0-40 m were determined using an echo sounder complimented with video surveys. A Garmin 135 GPS Map unit coupled with a Racal differential unit was used to collect positional and depth information. The accuracy of this unit was assessed and found to vary no more than 12 m over a three-hour period. This unit was linked directly to a field laptop through a COM port connection. Data on depth, substrate type (identified from echosounder and video drops), differentially corrected Global Positioning System (DGPS) data, and comments on the biotic community present (identified from video drops) were logged to file using the software program *SeaBed Mapper 2.4*.

FRV *Poolta* with a Furuno 600L colour sounder was used for habitat discrimination at 50 and 200 Khz. The 50 Khz signal gave better substrate definition in deeper waters (>30 m). The 200 Khz signal was used by preference as most of the survey work from this vessel was done in shallow waters. Different substrate types were characterised by differing sounder traces based on their roughness and hardness. This signal was interpreted in the field in conjunction with video camera drops, which were also used to validate signal interpretation, enabling good habitat discrimination. In shallower waters (<5 m), it was often possible to determine substrate type by using an underwater viewer. Hard substrates were indicated by strong second echoes on the sounder output, while rough substrates were characterised by long tails on these traces. This signal was interpreted in the field and logged in real time. This method allowed the exact location of habitat boundaries to be recorded.

Offshore mapping was conducted from the FRV *Challenger*. This vessel was equipped with a Simrad EK60 scientific sounder running on 120kHz. The sounder output was logged using *Echoview* software supplied by Sonardata Pty Ltd. This is a software package designed to display and analyse acoustic data from scientific echosounders. As for the inshore mapping, primary habitat discrimination was based on a visual assessment of the sounder output. These habitat classifications were logged against depth and position (GPS) into the *SeaBed Mapper 2.4* software in real time. Video drops were used to validate sounder interpretations.

Logged sounder data from the Simrad EK60 was analysed in *Echoview* integrating the tail of the first echo (roughness) and the entire second echo (hardness). This was used to refine and confirm the field based visual interpretations of sounder trace. The combined data was imported into the *Arcview3*.2 GIS platform and habitat boundaries digitised.

For this survey, substrates/habitats were distinguished and noted in the field in real time rather than interpreted from post-processing of recorded sounder signals. This provided the advantage of being able to incorporate local area irregularities into the interpretation of the sounder signal on-site and by the validation of signals whenever there was doubt about the substrate.

Field data was sampled at fixed time intervals adhering to a zigzag pattern of transects perpendicular to the coast. These transects were generally at around 200 m intervals along the coast, but were more frequent where habitats changed rapidly or had patchy distributions.

The software program *ArcPad* was employed in the field to display previous transects and ensure a regular field-sampling regime. Habitats were broadly categorised into four main groupings. These consisted of reef, unvegetated unconsolidated substrates, sponge and seagrasses. Each of these broad categories were broken down into numerous sub-categories based on relief for reefs, seagrass blade density, percentage cover for sponges and the consolidation of substrate (see Table 1 for detailed descriptions).

A submersible digital colour video camera was deployed at selected sites to verify echo-sounder classifications and obtain more detailed information on habitat attributes (Fig. 2). In addition, video transects were conducted at regular intervals on rocky reef areas perpendicular to the shore along the depth gradient. Depth, substrate and position for the video drops were recorded and the substrate and dominant species present at regular depth intervals entered into *SeaBed Mapper 2.4* for each transect. The video footage was also reviewed in the laboratory, and in conjunction with the field notes, used to identify the dominant cover forming species, namely macroalgae, seagrass and large invertebrates such as sponges, seawhips and sea squirts. This information was correlated against depth to determine characteristic biotic community types for combinations of each of the physical variables or habitats. A representative section of video footage was taken from a range of depths at each video transect site and archived.

Table 1. Definitions of substrate types and habitat categories used in this study

Rocky reef
High profile reef The term high relief was used when the apparent depth of hard substrate changed rapidly on the sounder. It usually coincided with steep underwater cliffs adjacent to or away from the coast but also includes areas of high rugosity where depth variation was greater than 4-10 m over short distances.
Medium profile reef The term medium relief referred to areas where the bottom was hard and the relief changed regularly. Changes in depth are usually from 1-4 m over short distances.
Low profile reef This definition referred to hard bottom when there was very little change in the relief. This category occasionally overlapped with the patchy reef and hard sand categories.
Patchy reef This category commonly occurred on the seaward side of coastal reef areas. It consisted of reef elements, including boulders and rocks, intermittently outcropping from unconsolidated sediments, principally sand. In deeper water it could easily be confused with the 'hard sand' category due to the decreasing discrimination power of the sounder signal with depth. Also, 'hard sand' type substrates such as shells and gravel were often associated with patchy reef.
Dense Sponge This habitat occurs on consolidated bottom with mostly medium and low profiles. A large diversity of sponges occur within this habitat which often also contains the stalked ascidian *Pyura* sp and octocorals, soft corals, anemones and bryzoans. The habitat was characterised by a sounder reflectance that was rougher than hard sand. The sounder interpretation was confirmed through video analysis.
Unconsolidated unvegetated substrate
Sand Sand refers to areas of coarse unconsolidated sediments and was generally characterised by a distinct second echo on the sounder trace.
Sand Hill This refers to areas of sand creating unordered sand dunes up to 15 m in height with no underlying hard substrate. These were generally sculptured by channelling of strong currents predominantly occurring on the more exposed western side of the island group.
Hard sand Hard sand refers to unconsolidated substrates containing elements that confound the sounder output causing the signal to appear either harder or rougher than would be expected from that substrate. There are several factors that lead to a substrate being classified as hard. These include large grain size, compacted or rippled sand, shell matter (either whole shells or shell grit) or biological material.
Sparse Sponge This habitat was defined by a low cover of sponge on a high proportion of unconsolidated sand and was slightly rougher and harder than sand but considerably less than dense sponge.
Unconsolidated vegetated substrate
Seagrass Due to the absence of aerial photographs of the Kent Group, seagrass beds were identified on the basis of echosounder interpretation and targeted video drops. The species composition and % cover of the beds was defined through analysis of video transects. The habitat mapping details the extent of the larger beds of these species, however, it should be noted that seagrass was at times also present in small amounts where reef meets sand and within patchy reef in more sheltered waters.
Patchy seagrass This category refers to beds that consist of patches of seagrass separated by patches of sand that are larger than those of the seagrass.

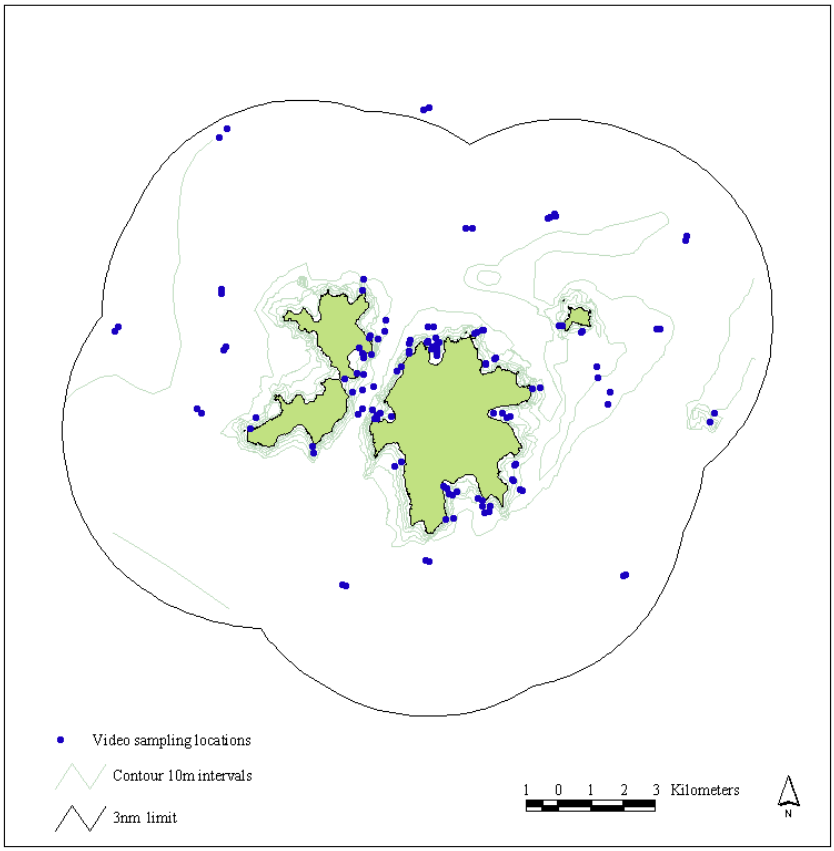

Fig. 2. Locations of video surveys of the Kent Group

2.2 Habitat Mapping

Data files from *Seabed Mapper 2.4* were imported into *ArcView 3.2* and point data attributed from benthic habitat classification used to generate shapefiles by on-screen digitising. At the 1:2,000 scale the points were carefully connected to form polygons of similar habitat type and delineate boundaries.

Depth data logged in the field was tidally corrected and assessed for errors before initial mapping commenced. Depth contours were generated in *ArcView* 3.2 with the Spatial Analyst extension. A triangular irregular network (TIN) surface was formed as an interpolation of the field collated point and contour lines at 10 m intervals were created. Further details on the method of tidal correction and contour development is presented in Barrett *et al*. (2001).

The 3D visualisations were created in ArcScene (*ESRI*) using the extension 3D analyst. A 10 m grid was generated from the original bathymetric point data combined with spot height data generated from the original land contours provided by the LIST (Land Information Service Tasmania). The surface was displayed in ArcScene and the topography was built from the data within the surface with a minimal Z unit conversion exaggeration.

The subtidal component was draped with the habitat polygons generated out to the 3 Nm limit and the land was coloured using topographic hillshading. The Animation Manager (a product of the 3D analyst extension) was utilised to generate the ‘fly though’ and ‘fly over’

movies. The Animation Manager allows routes to be sampled across the 3D image and exported in 'avi' format.

Two types of error can be inherent in habitat mapping spatial data. These are positional error and attribute error. Positional error is the offset of points, lines and polygons from their true location in the real world. Attribute accuracy relates to the non-positional characteristic of a spatial data entity, which is the information stored on a feature. This accuracy is determined by comparing the category description or value assigned in the mapping to that recorded in the field. Accuracy assessment often requires extensive field surveys to verify interpreted information, and this can pose problems in the marine environment as the physical setting can sometimes restrict detailed mapping being completed. Though the field data produced a reliable record of the benthic habitats, the nature of the field transects must be accounted for in the assessment of the positional error of the habitat. For example, some areas of the region were too shallow to survey by boat and the 200 m zig-zag transect to shore may at times neglect habitats smaller than the sampling interval.

One 1:120,000 map illustrates the areas within the 3Nm offshore limit. Sixteen 1:10,000 habitat maps were generated for the inshore areas of the Kent Group of islands (Fig. 3).

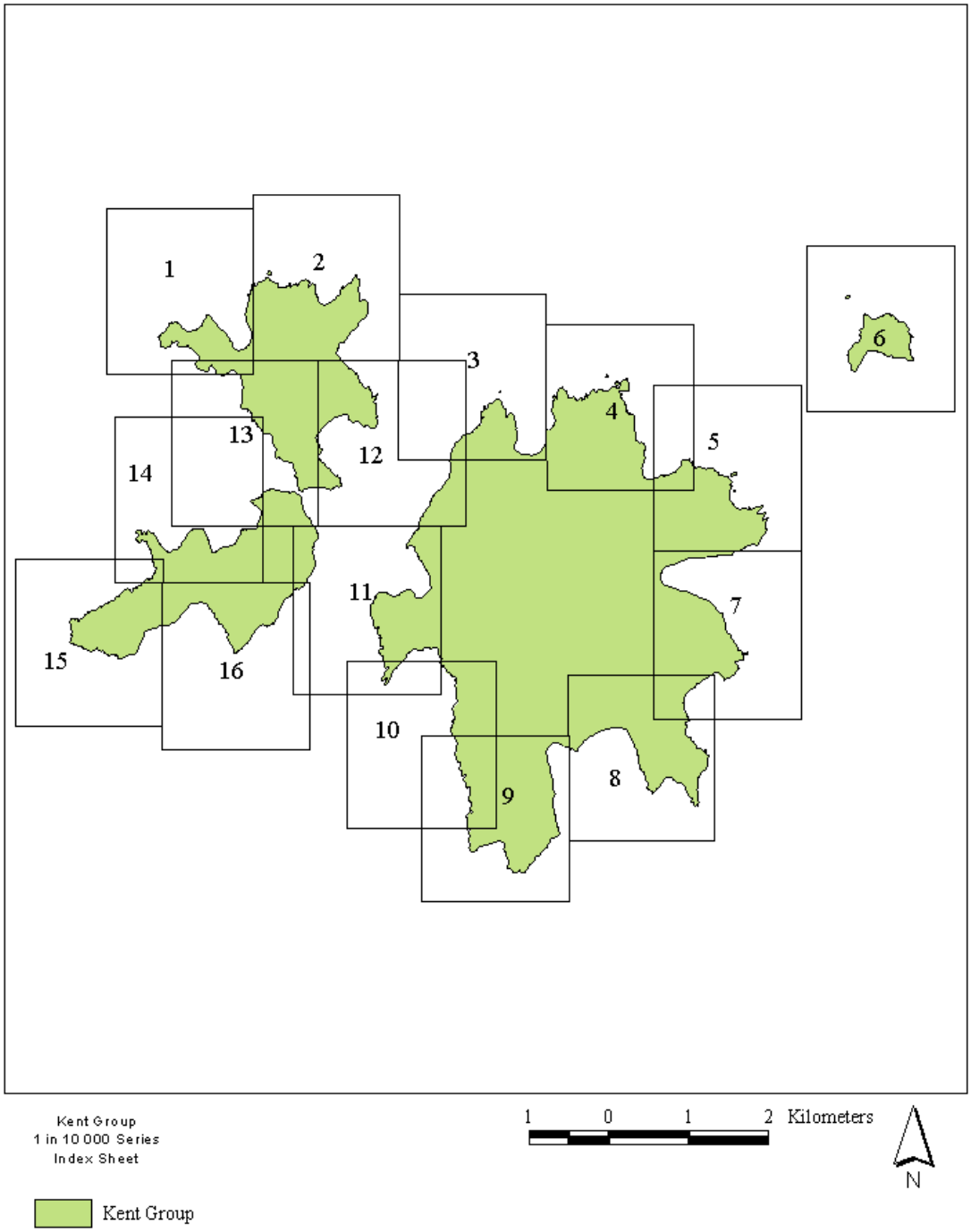

Fig. 3. Location of 1:10,000 habitat maps presented for the Kent Group of islands

2.3 Habitat Area Calculation

ArcView 3.2 was used to analyse the spatial data collected in this project. The habitat polygons were categorised by using the *Geoprocessing Wizard* extension. The merge option was used to combine the habitat polygons with depth contour polygons. This resulted in all habitat polygons being divided into six depth categories (0-10, 10-20, 20-30, 30-40, 40-50, and 50-60 m). Habitat type was then calculated for each depth range.

3. Results

3.1 Bathymetry

The Kent Group of islands are characterised by a steep inshore coastline and numerous small shallow bays. All of the islands coastlines are dominated by cliffs which generally extend underwater, with the 20 m depth contour usually being less than 100 m from the shoreline, and the 40 m contour usually less than 400 m from the shore (Fig. 4).

The many indented bays such as West Cove, Garden Cove, Squally Cove and East Cove have more gradual slopes, and the waters are relatively shallow. In these sheltered coves the 40 m contour extends up to 1 km from the head of the bays. Murray Pass is characterised by steep sides dropping to around 50-60 m through the main channel. The majority of the 3 Nm limit around the Kent Group is dominated by depths of between 50-60 m, with a maximum depth of around 65 m attained to the west of the islands.

An extensive bank mostly between 20-30 m occurs south of North East Island and extends for around 5 km, becoming narrower in the southern end. A small area of similar depth also occurs to the north-west of North East Island.

Table 2. Summary of area (km^2) of 10 m depth strata in the Kent Group of islands out to the 3Nm limit

Depth (m)	Area (km^2)	% of area
0-10	3.8	1.3
10-20	3.7	1.3
20-30	4.5	1.4
30-40	9.5	3.3
40-50	29.3	10.1
50-60	225.5	77.5
60-70	14.9	5.1
TOTAL	**291.2**	

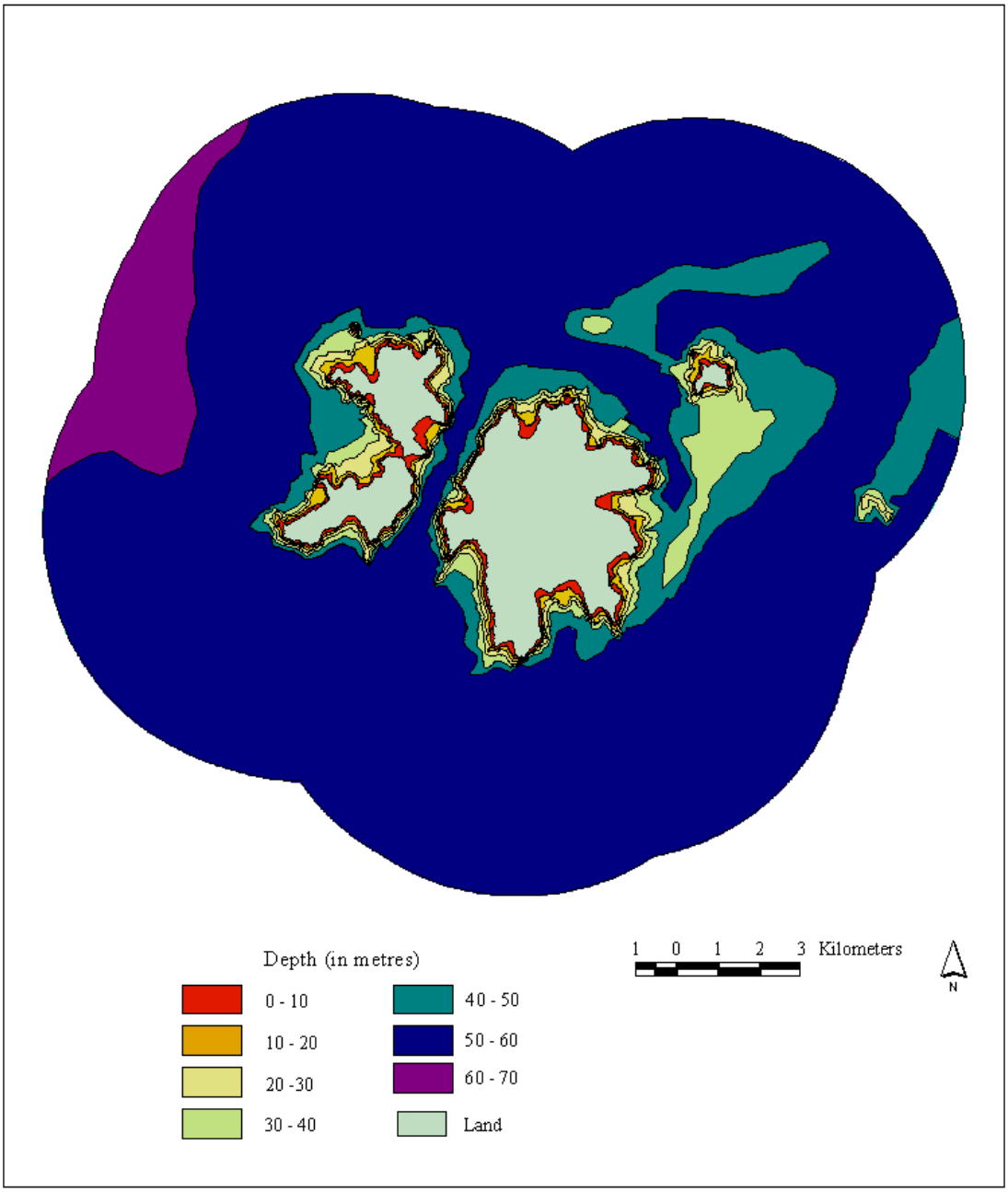

Fig. 4. Bathymetry in 10 m depth intervals of the Kent Group of islands out to the 3 Nm limit

3.2 Habitat Distribution

The Kent Group of islands has a diverse range of habitats reflecting the regions bathymetry, oceanography and geomorphology. These three factors have resulted in rocky reefs of varying exposure and depth, sheltered coves with seagrass and extensive areas of sponge and sand habitat (Fig. 5). In terms of the total survey area, the Kent Group is dominated by hard sand and sparse sponge habitat that combined make up around 87% of the total area (Table 3). However, the distribution and extent of habitat clearly varies by depth, with shallow waters (0-20 m) dominated by reef (mostly low and medium profile) with lesser amount of sand and seagrass (Table 3). A 3-dimensional visualisation of the habitats and bathymetry within the 3 Nm limit of the Kent Group of Islands is presented in Appendix 2.1.

The mid depth range (20-40 m) still contains significant areas of low and medium profile reef although an increasing proportion of hard sand habitat occurs in the deeper parts of this strata. Over 40 m the habitats are predominantly hard sand and sponge (mostly sparse sponge).

Murray Pass is an area of particularly high habitat diversity due to the presence of depths >40 m and strong currents providing a suitable environment for sponge habitat, rocky reefs with varying depth and exposure and several sheltered coves with seagrass and shallow sand. A 3-dimensional visualisation of the habitats and bathymetry of Murray Pass is presented in Appendix 2.2.

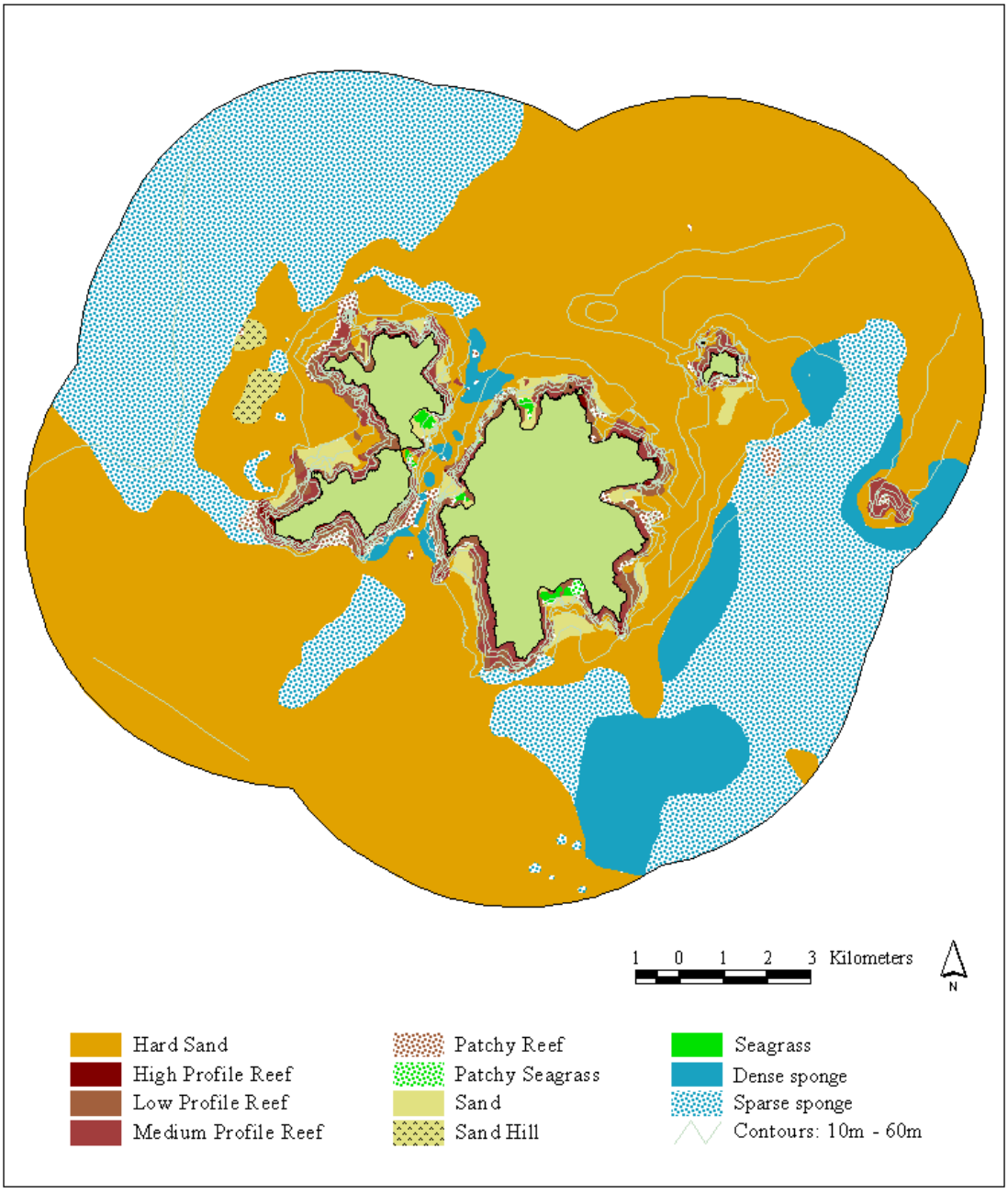

Fig. 5. Distribution of seabed habitats at the 1:120,000 scale in the Kent Group of islands out to the 3 Nm limit

Table 3. Summary of area (km^2) of habitat types by 10 m depth strata in the Kent Group of islands out to the 3 Nm limit

Depth (m)	0-10	10-20	20-30	30-40	40-50	50-60	60-70	Total
Low Profile Reef	1.0	1.1	1.2	1.2	0.7	0.1	0.0	5.2
Med Profile Reef	1.9	1.5	1.4	1.2	0.7	0.1	0.0	6.7
High Profile Reef	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.6
Patchy Reef	0.1	0.2	0.4	0.4	0.9	0.5	0.0	2.5
Sand	0.3	0.3	0.5	1.3	1.2	0.1	0.0	3.8
Sand Hill	0.0	0.0	0.0	0.0	0.0	1.2	0.0	1.2
Hard sand	0.0	0.2	0.9	5.3	21.6	133.5	0.9	162.4
Seagrass	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.4
Patchy Seagrass	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
Dense Sponge	0.0	0.0	0.0	0.0	2.2	16.4	0.0	18.6
Sparse Sponge	0.0	0.0	0.0	0.1	1.9	73.6	14.1	89.7
Total (km^2)	**3.8**	**3.7**	**4.5**	**9.5**	**29.3**	**225.5**	**14.9**	**291.2**
% of area inside 3 Nm	**1.3**	**1.3**	**1.5**	**3.3**	**10.0**	**77.4**	**5.1**	**100.0**

3.2.1 Rocky reef

The granite shores of the Kent Group of islands are generally cliffs or steep slopes, and for most of the coastline they extend below the waterline as boulder-strewn reef to depths of up to 50 m before meeting the sand edge. Rocky reef habitat had a combined reef area of approximately 15 km^2, which represents around 5% of the overall habitats in the region (Table 4).

The reef typically extends to between 200-300 m offshore and to depths of 40 m for most of this coast (Figs. 7-22), and while most reef habitat is found within this depth range there are a number of notable exceptions (Table 4). These include reef extending to below 50 m depth in Murray Pass (Figs. 17, 18), and greater offshore extension of reefs on the western side of Dover Island (Figs. 20, 21) and between Erith Island and North Rock (Fig. 7). In sheltered embayments such as East Cove, Garden Cove, Winter Cove and Squally Cove on Deal Island and West Cove on Erith Island there is less reef development, with the sand edge extending inshore to form sandy beaches in the mid sections of these bays.

The islands' granitic structure has resulted in reefs that are often structurally complex, and may be dominated by large granite blocks with associated clefts, ledges and caverns (Edgar, 1984; Barrett and Edgar, 1992). This adds to the range of habitats available in a small area and often results in sponges and other sessile invertebrates occurring immediately adjacent to reef dominated by macroalgae. There are also some significant areas of patchy reef that are interspersed with sand (Appendix 1.3, Video 1), and in some places, seagrass.

Rocky reef occurs adjacent to most of the coastline in the Kent Group with the majority of reef subject to sub-maximal wave exposure with prevailing west to south-westerly winds giving west to south facing coasts the greatest exposure. Exposed reef in the depth range from 0-40 m is relatively evenly distributed throughout the Group. However, reef below this depth is essentially restricted to sections of reef near the northern end of West Cove and South Bluff on Deal Island, the western shore of Erith Island and the west and southern shores of Dover Island. Few locations appear to have reef extending to depths greater than 50 m (Table 4), the most notable of these are South Bluff on Deal Island and rocky outcrop near West Bluff on Dover Island (Fig. 21). Reefs on the exposed coasts typically have

Phyllospora comosa as the dominant algae (Appendix 1.6, Video 2), extending from the immediate subtidal zone to depths of 10 to 20 m where it is gradually replaced by *Ecklonia radiata* (Appendix 1.12, Video 3).

At depths below 25 m, *Ecklonia radiata* is gradually replaced by invertebrate assemblages (most notably sponges), until approximately 40 m where it is completely replaced by invertebrates. Due to adverse weather conditions and time constraints, insufficient video drops were conducted on rocky reefs during this survey to be able to comprehensively describe the algal assemblages present throughout the island Group. This was particularly the case in depths of 0-5 m where conducting video drops was difficult and at times dangerous.

From the video transects undertaken during this survey it appears that the depth to which *Phyllospora comosa* dominates is similar between western and eastern coastlines, suggesting that the overall exposure to water movement is similar between these aspects. While the western facing coasts are subject to prevailing winds they are protected from oceanic swells, whereas eastern facing coasts are subject to less wind driven seas but exposed to oceanic swells from the east.

Within the sheltered embayments listed earlier, wave energy is greatly reduced and *Phyllospora comosa* is replaced as the dominant algae by *Ecklonia radiata* and *Cystophora monilifera* (Appendix 1.8, Video 4). Most reefs within the more sheltered locations are restricted to depths of less than 10 m. Obviously there are components of the coastline that intergrade between the sheltered embayments and the exposed coast, particularly within Murray Pass, much of which is protected from wave action by the presence of the islands on either side of the Pass. The most notable feature of reefs within Murray Pass is the extent of deep reef that can be found in relatively sheltered waters. On the headlands to the north of both East Cove and West Cove these reefs extend into depths > 50 m, where below the algal zone, they contain invertebrate assemblages structured by the strong currents flowing through the Pass.

The surveys also revealed a large number of urchin barrens which result from intense grazing by the long-spined urchin, *Centrostephanus rodgersii* (Fig. 6); (Appendix 1.18, Video 5). Barrens constitute a distinct habitat of their own within the overall depth/exposure classification of the reefs. The habitat is characterised by the almost complete absence of macroalgae, and an enhanced presence of planktivorous fish. Barrens can extend from depths of 4 m to over 30 m and are most characteristic of the more sheltered locations.

Table 4. Summary of area (km^2) of reef habitat by 10 m depth strata in the Kent Group of islands out to the 3 Nm limit

DEPTH RANGE	Patchy reef	Low profile reef	Med profile reef	High profile reef	TOTAL
0-10m	0.1	1.0	1.9	0.3	3.3
10-20m	0.2	1.1	1.5	0.1	2.9
20-30m	0.4	1.2	1.4	0.1	3.1
30-40m	0.4	1.2	1.2	0.0	2.8
40-50m	0.9	0.7	0.7	0.0	2.3
50-60m	0.5	0.1	0.1	0.0	0.7
60-70m	0.0	0.0	0.0	0.0	0.0
TOTAL	**2.5**	**5.2**	**6.7**	**0.6**	**15.1**

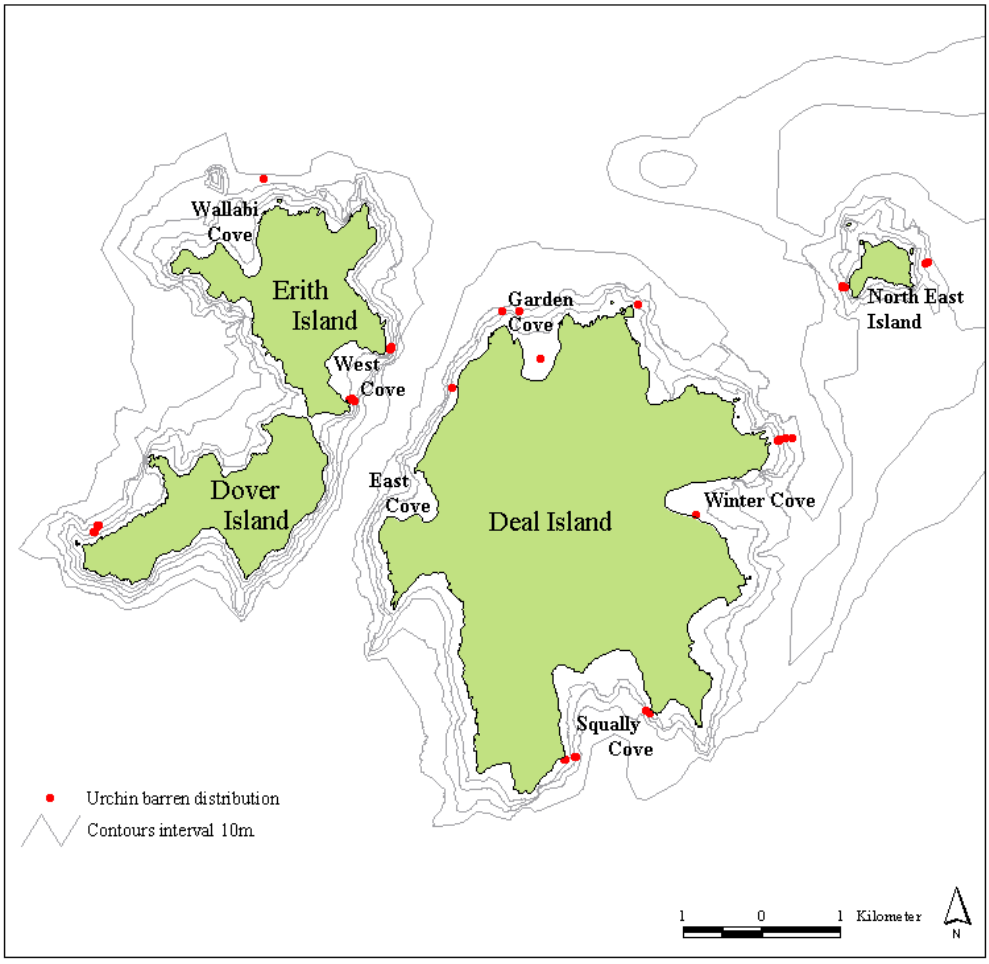

Fig. 6. Distribution of locations where urchin barrens were identified in the Kent Group of islands

3.2.2 Seagrass

Seagrass beds in the Kent Group are restricted to several of the large coves inside Murray Pass and Squally Cove at southern Deal Island. The beds occur in depths of around 5 to 25 m and have a total area of 0.6 km^2 (Table 5), representing around 0.2% of all habitats in the survey region of the Kent Group. Slightly more seagrass habitat occurs in depths of 10-20 m than shallower, with much of the inner margin of the sheltered coves dominated by sand or fringing rocky reef. In some areas very sparse blades of *Halophila* were present down to

around 40 m, but were of such a low density not to be classified as a distinct seagrass bed. There were also some areas where small amounts of seagrass was present in between patches of reef but were of such a small size that they were not possible to map at the scale presented in this report.

Firstly, the seagrass bed in Garden Cove consists of an area of patchy *Posidonia* starting in around 5 m (Appendix 1.3, Video 6), an area of *Heterozostera* to around 12 m and an area of mixed *Heterozostera* and *Halophila* to around 15 m (Appendix 1.3, Video 7). A bed of *Halophila* that decreases in percentage cover with increasing depth occurs out to around 28 m (Fig. 9); (Appendix 1.3, Video 8).

An extensive area of seagrass occurs in Squally Cove and is dominated by *Posidonia* with small amounts of *Halophila* (Figs. 14, 15); (Appendix 1.9, Video 9). In the western part of the Cove the seagrass occurs adjacent to shallow fringing reef while in the east a broad area of patchy seagrass occurs up to shore. In East Cove, a seagrass bed occurs out to around 22 m in depth and consisted of distinct areas of *Posidonia* (Appendix 1.11, Video 10) and a mixed bed of *Heterozostera* and *Halophila* (Fig. 17); (Appendix 1.11, Video 11). The *Posidonia* bed had a percentage cover of around 60% while the areas of *Heterozostera* and *Halophila* were considerably less dense with covers of around 10-30%.

A large bed occurs in West Cove in south-east Erith Island that was dominated by *Heterozostera* with a cover of around 50 % and a high biomass of associated red algae (Fig. 18); (Appendix 1.12, Video 12). There were also some areas of *Halophila* on the deeper margins of the bed. Immediately south in the bay between Erith and Dover Islands there was an extensive area of *Posidonia* and *Heterozostera* on the inner margin with patchy *Halophila* extending out to around 40 m (Figs. 18, 19). There was also a small bed of seagrass on the eastern side of Murray Pass that was dominated by *Halophila* but often intersperse with patch reef (Fig. 18); (Appendix 1.12, Video 13).

Table 5. Summary of area (km^2) of seagrass habitat by 10 m depth strata in the Kent Group of islands out to the 3Nm limit

DEPTH RANGE	Patchy seagrass	Seagrass	TOTAL
0-10m	0.1	0.1	0.2
10-20m	0.1	0.2	0.3
20-30m	0.0	0.0	0.0
30-40m	0.0	0.0	0.0
40-50m	0.0	0.0	0.0
50-60m	0.0	0.0	0.0
60-70m	0.0	0.0	0.0
TOTAL	**0.2**	**0.3**	**0.5**

3.2.3 Sponge

While sponge habitat is defined under both reef and unconsolidated categories, it is detailed separately here as it covers a significant area within the depths >40 m around the Kent Group of islands representing around 40% of the habitats in those strata. The habitat consisted of two generally distinct types, sparse and dense, the discrimination of which was based on the acoustic reflectance, and percentage cover and morphological diversity

identified from video analysis. Sparse sponge consisted of mainly sand interspersed with small clumps of low profile sponge with little variation on growth forms (Appendix 1.15, Video 14). This included habitat with sponge growing on dead shells.

Dense sponge occurred primarily on more consolidated substrates with a higher relief where the cover of sponge was quite high (Appendix 1.11, Video 17, 18 and 19). This habitat had a much larger variation in growth forms and species diversity with encrusting, erect and branching forms. The habitat often had large numbers of the ascidian *Pyura* sp. and several types of octocorals, soft corals, anemones and bryzoans of various growth forms. However, there is often no rapid transition from sparse to dense sponge, with the increase in the amount of consolidated substrate, sponge cover and diversity often occurring gradually (Fig. 22); (Appendix 1.16, Video 15 & 20).

The majority of the sponge habitat around the Kent Group was found below 50 m (Figs. 5, 7-22, Table 6). To the west of the islands there was a broad band of sparse sponge mainly consisting of small tufts of sponge on a sandy substrate that extended as far as the 3 Nm survey limit. To the east there was a large band of sparse sponge stretching from the south-east tip of Deal Island to beyond North East Island and as far as the 3 Nm limit. This area of sponge also had significant areas of dense sponge, often on substrates approaching low profile reef. The other area of dense sponge was in Murray Pass where sponge was interspersed with patches of reef, hard sand and occasional seagrass on the shallower edges of the Pass (Appendix 1.9, Video 16). The sponges of the Pass were dominated by low tufting sponges, with finger sponges and gorgonian fans on the harder substrates associated with the sides of the Pass.

Table 6. Summary of area (km^2) of sponge habitat by 10 m depth strata in the Kent Group of islands out to the 3 Nm limit

DEPTH RANGE	Dense sponge	Sparse sponge	TOTAL
0-10m	0.0	0.0	0.0
10-20m	0.0	0.0	0.0
20-30m	0.0	0.0	0.0
30-40m	0.0	0.1	0.1
40-50m	2.2	1.9	4.1
50-60m	16.4	73.6	90.0
60-70m	0.0	14.1	14.1
TOTAL	**18.6**	**89.7**	**108.3**

3.2.4 Unconsolidated unvegetated habitats

Unvegetated habitats occurred at all depths around the Kent Group and consisted of three types; hard sand, sand and sand hills (Figs. 7-22). They were significant habitat types in the region and were dominated by hard sand, which covered an area of around 162 km^2 representing around 55% of all subtidal habitats (Table 7). Large differences, however, occurred in the distribution of sediment type around the island group. Hard sand consisted of coarse sand approaching gravel or sand with dead shell or shell grit with the substrate to the south of the islands having large volumes of dead scallop shells (Appendix 1.10, Video 21). The substrate to the north was coarser with more shell grit.

Sand habitat occurred primarily in the bays on each of the three main islands of Deal, Dover and Erith, often adjacent to the deeper margin of the fringing reefs in depths from 30 to 50 m (Table 7); (Appendix 1.10, Video 22). It also was the dominant sediment type within the areas of patchy reef, patchy seagrass and sparse sponge. Areas of sand hills, which are partially consolidated into calcarenite, occurred west of Erith and Dover Islands and had an area of around 1.2 km^2. These hills were in some places up to 10 m high.

Table 7. Summary of area (km^2) of unconsolidated unvegetated habitat by 10 m depth strata in the Kent Group of islands out to the 3Nm limit

DEPTH RANGE	Sand	Hard sand	Sand hill	TOTAL
0-10m	0.3	0.0	0.0	0.3
10-20m	0.3	0.2	0.0	0.5
20-30m	0.5	0.9	0.0	1.4
30-40m	1.3	5.3	0.0	6.6
40-50m	1.2	21.6	0.0	22.8
50-60m	0.1	133.5	0.0	133.6
60-70m	0.0	0.9	1.2	2.1
TOTAL	**3.7**	**162.4**	**1.2**	**167.3**

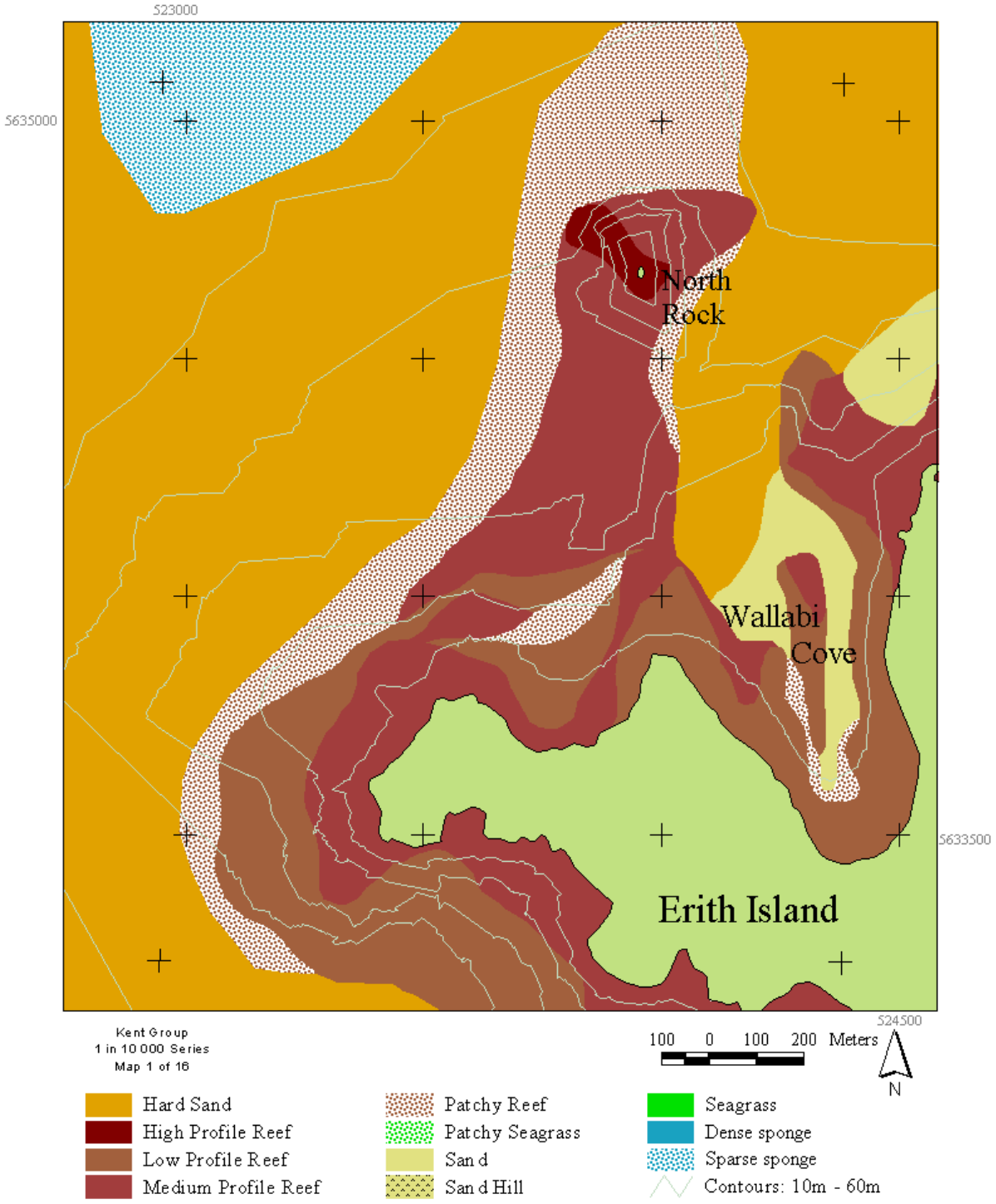

Fig. 7. Distribution of seabed habitats at 1:10,000 off north-west Erith Island

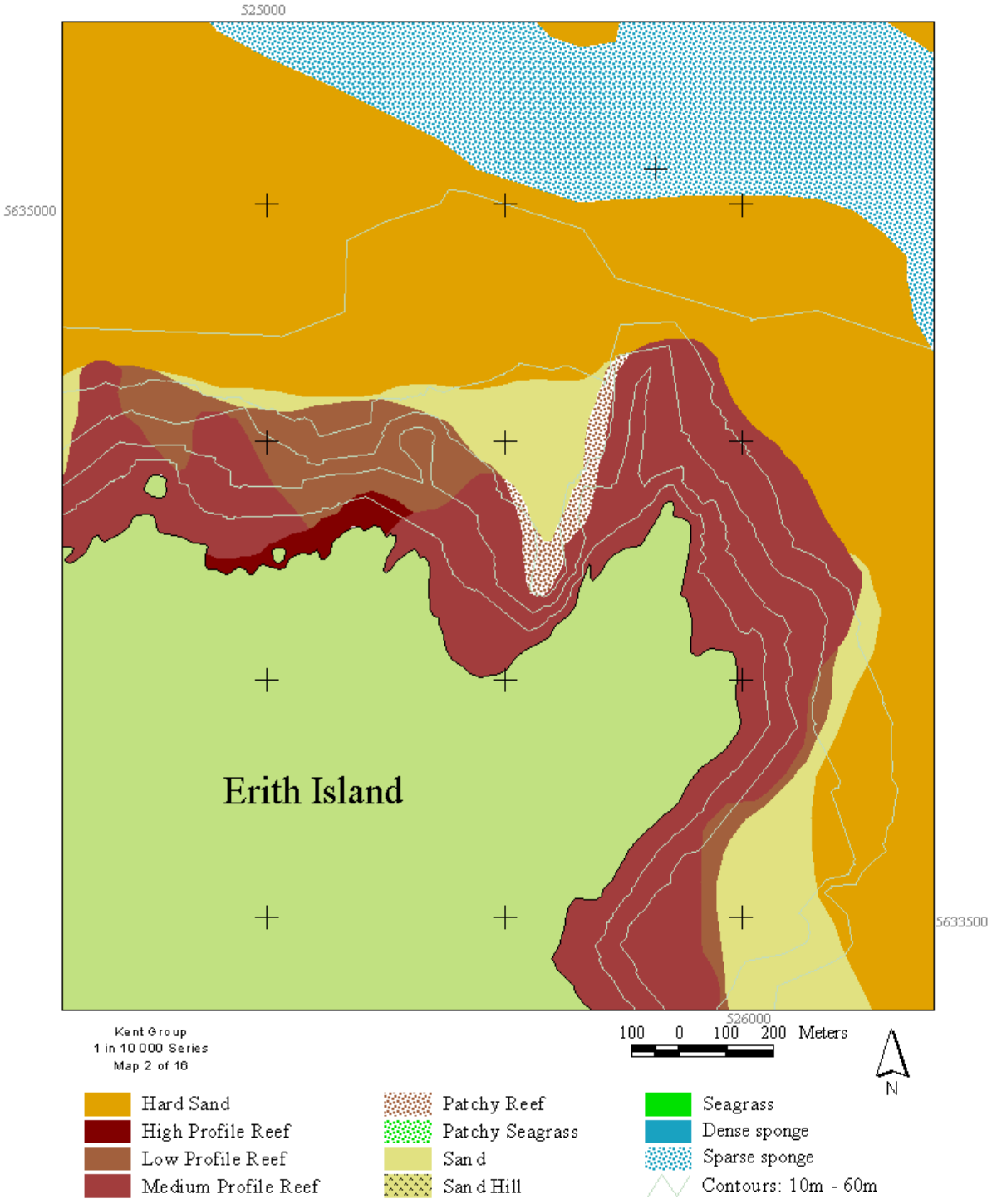

Fig. 8. Distribution of seabed habitats at 1:10,000 off north Erith Island.

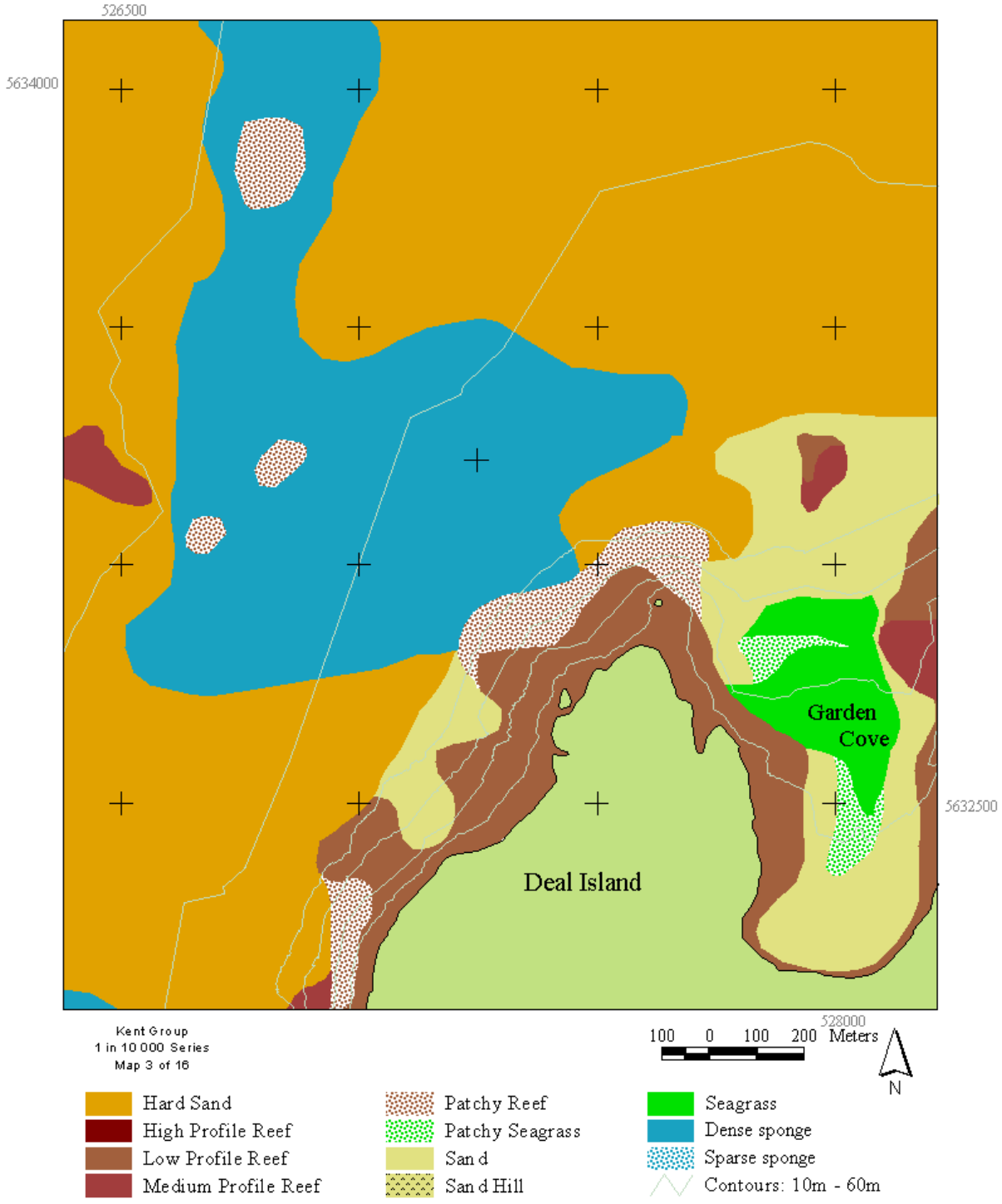

Fig. 9. Distribution of seabed habitats at 1:10,000 off north-west Deal Island

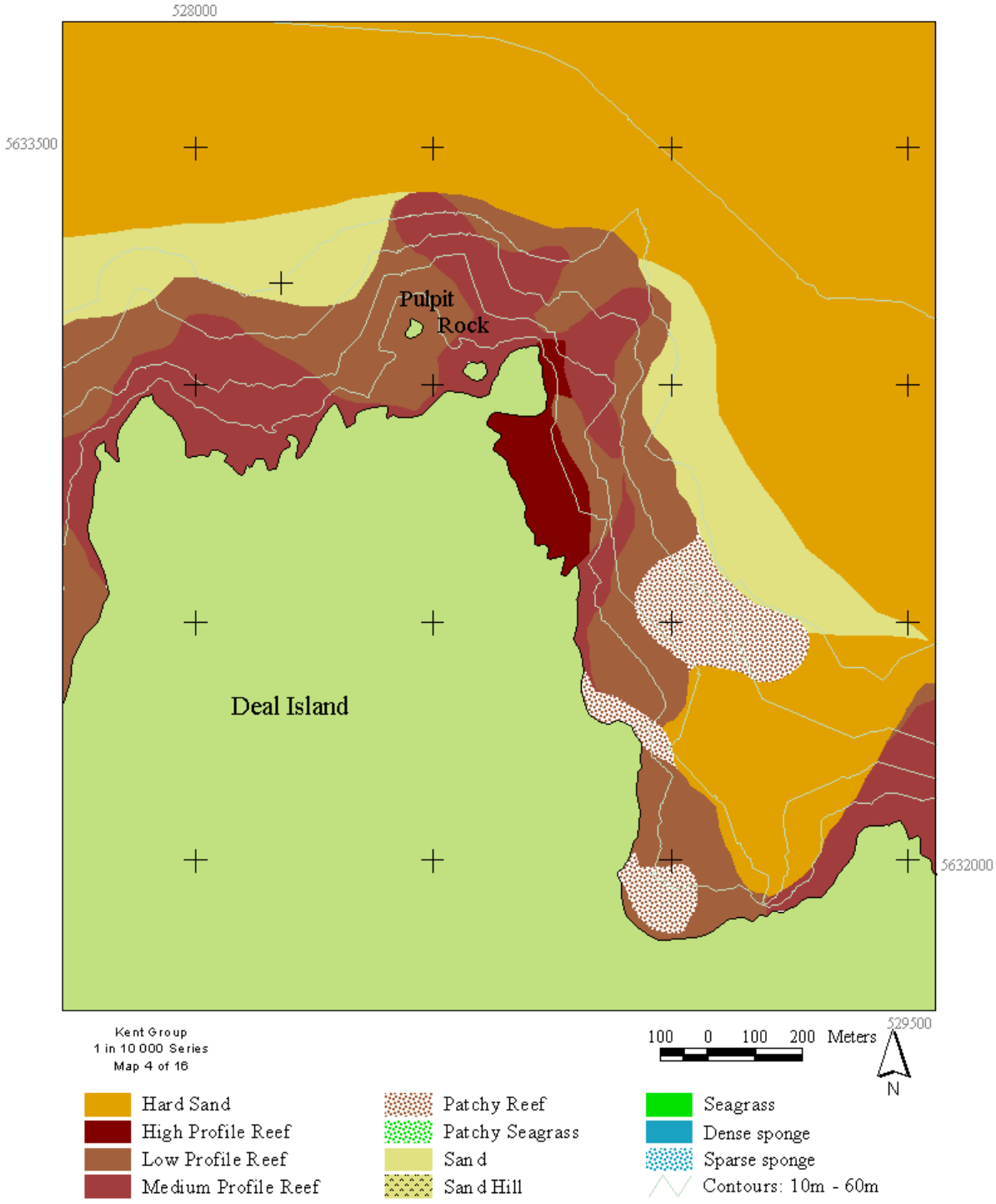

Fig. 10. Distribution of seabed habitats at 1:10,000 off north Deal Island

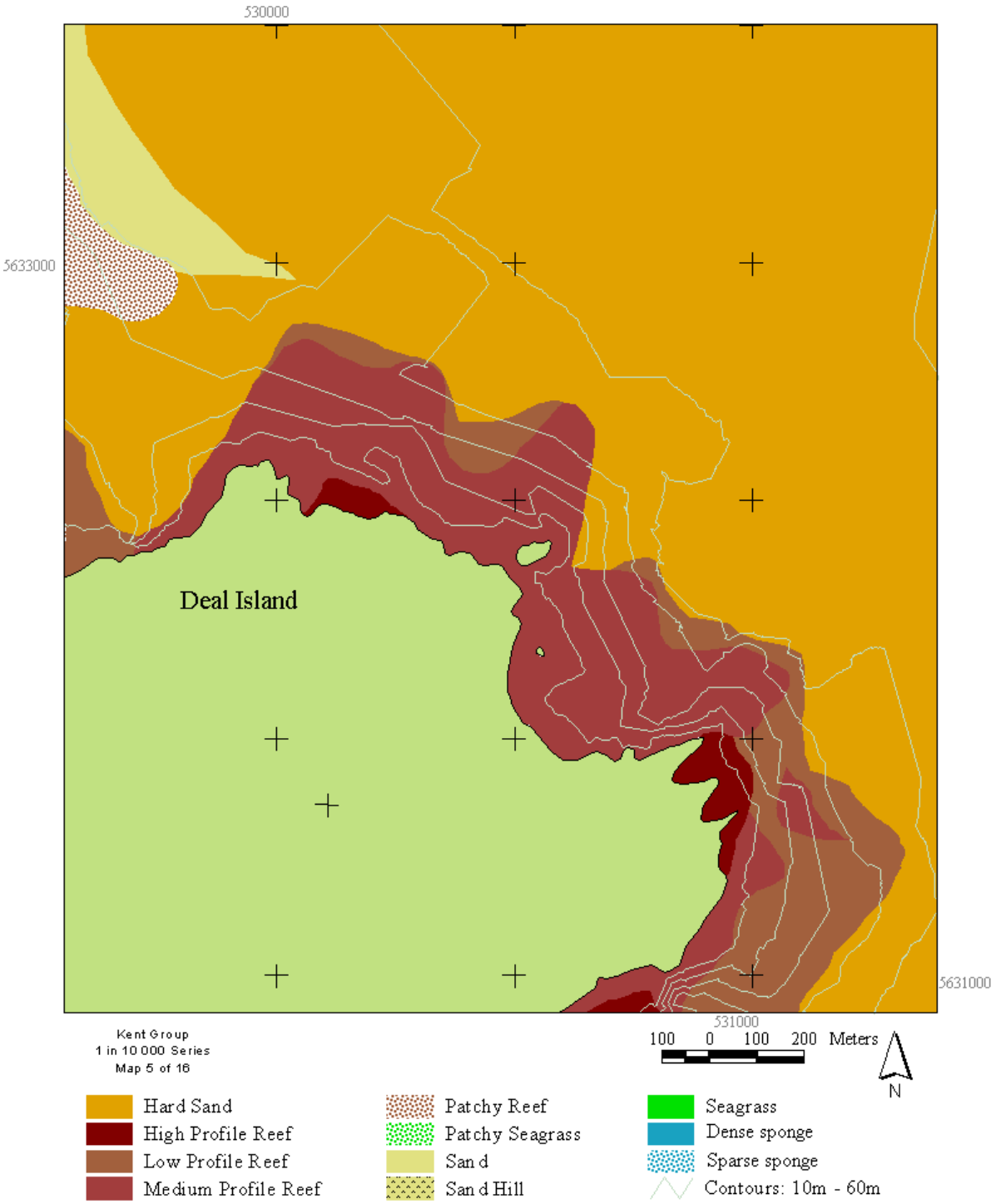

Fig. 11. Distribution of seabed habitats at 1:10,000 off north-east Deal Island

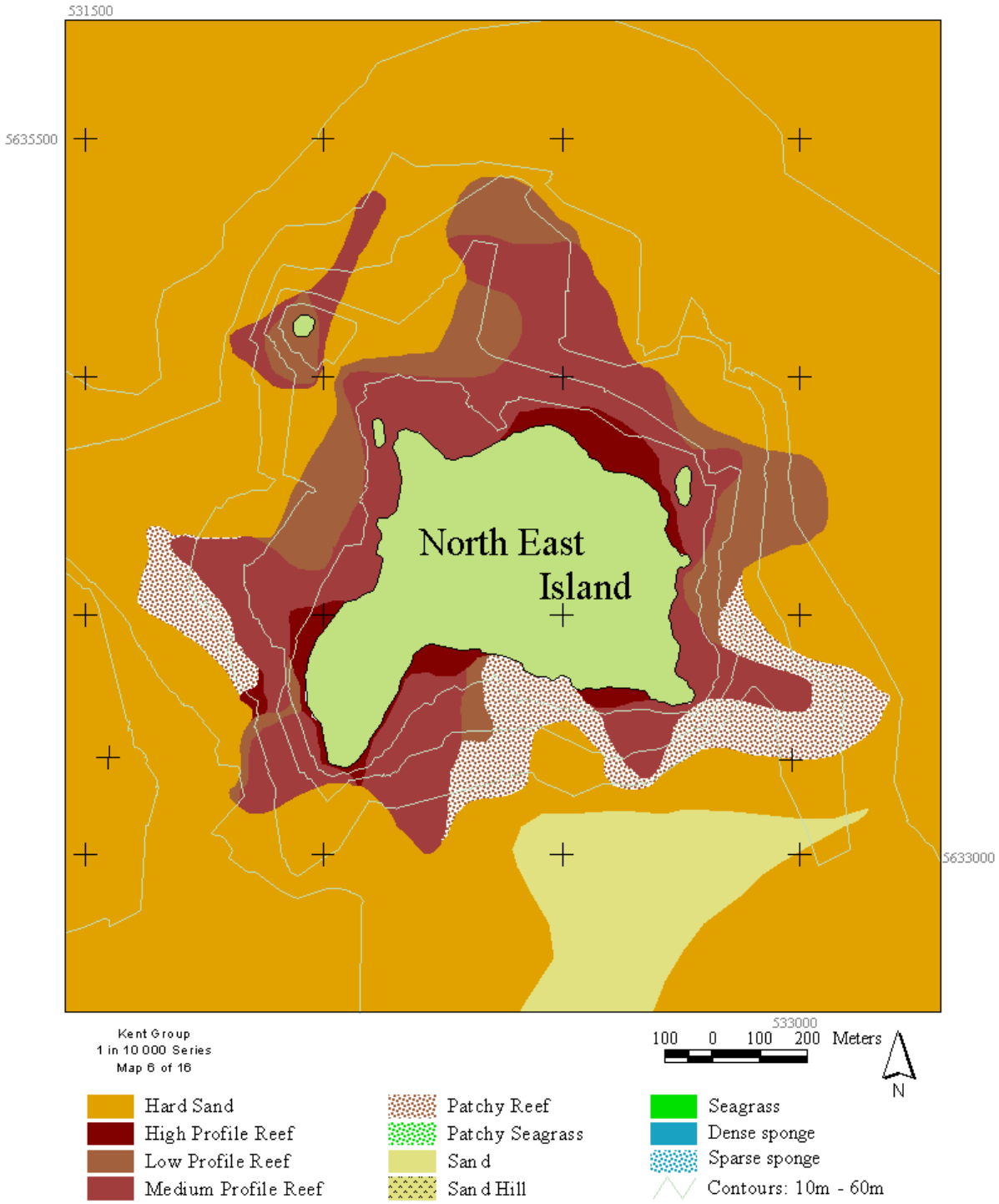

Fig. 12 Distribution of seabed habitats at 1:10,000 around North East Island

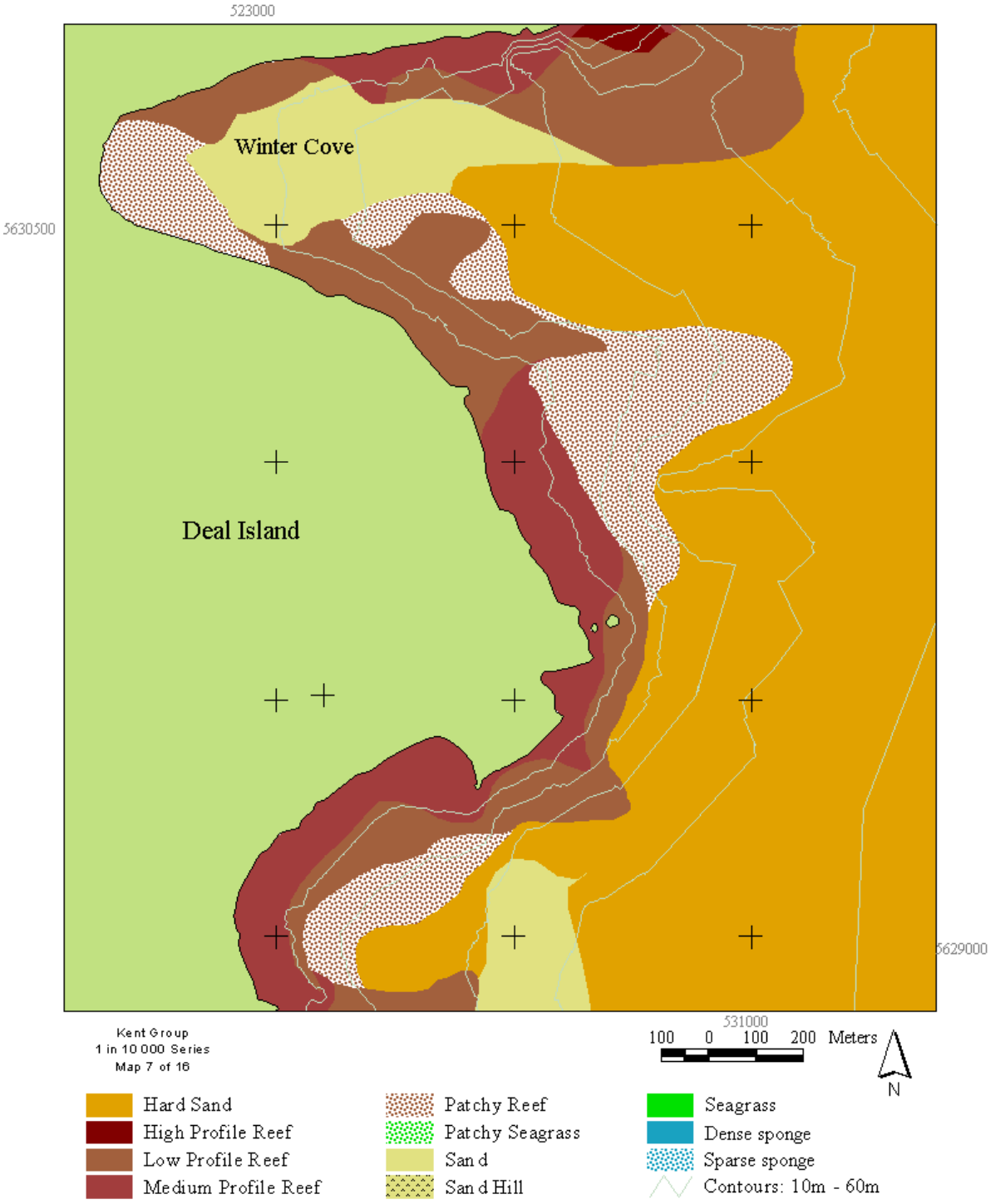

Fig. 13. Distribution of seabed habitats at 1:10,000 off east Deal Island

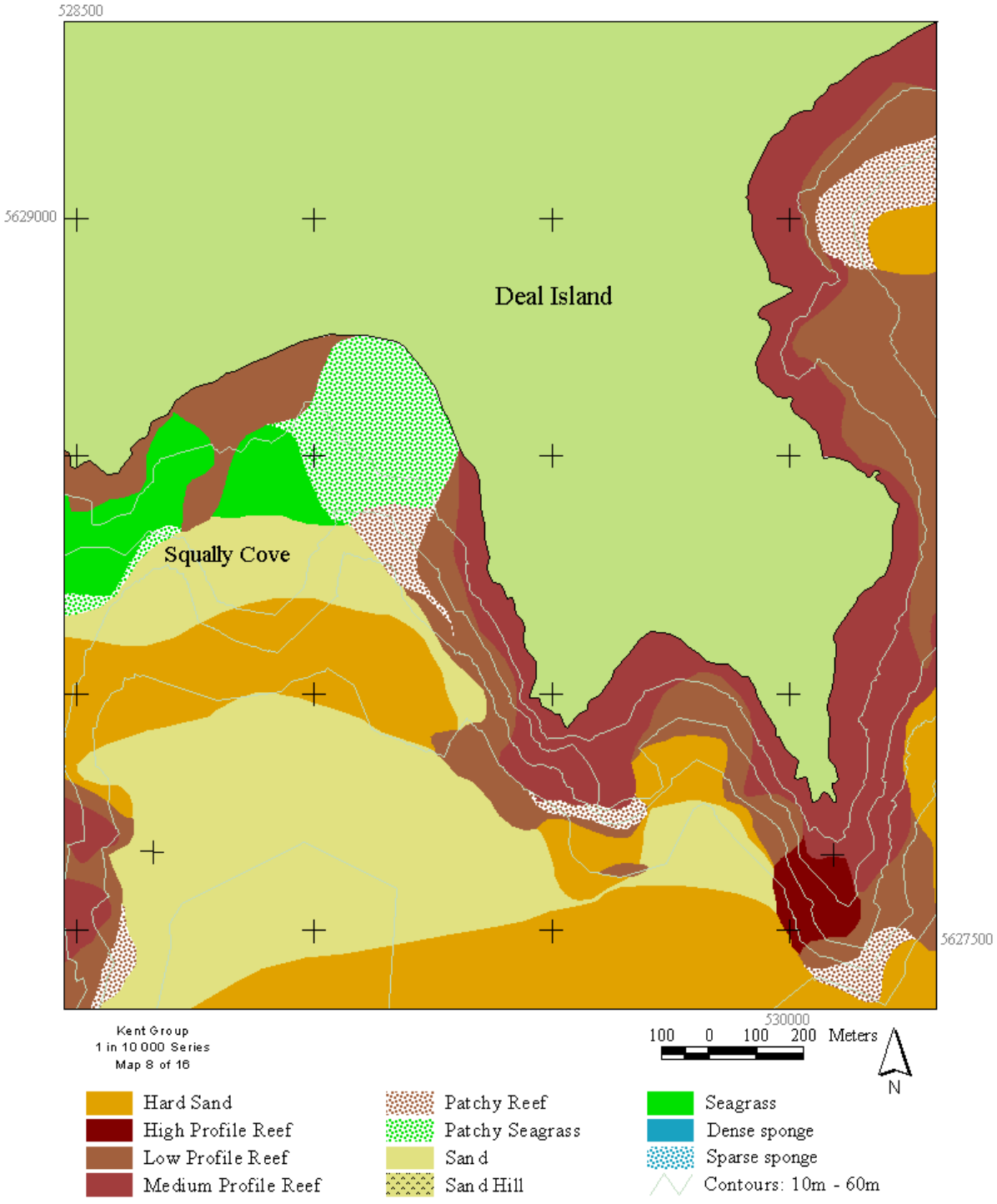

Fig. 14. Distribution of seabed habitats at 1:10,000 off south-east Deal Island

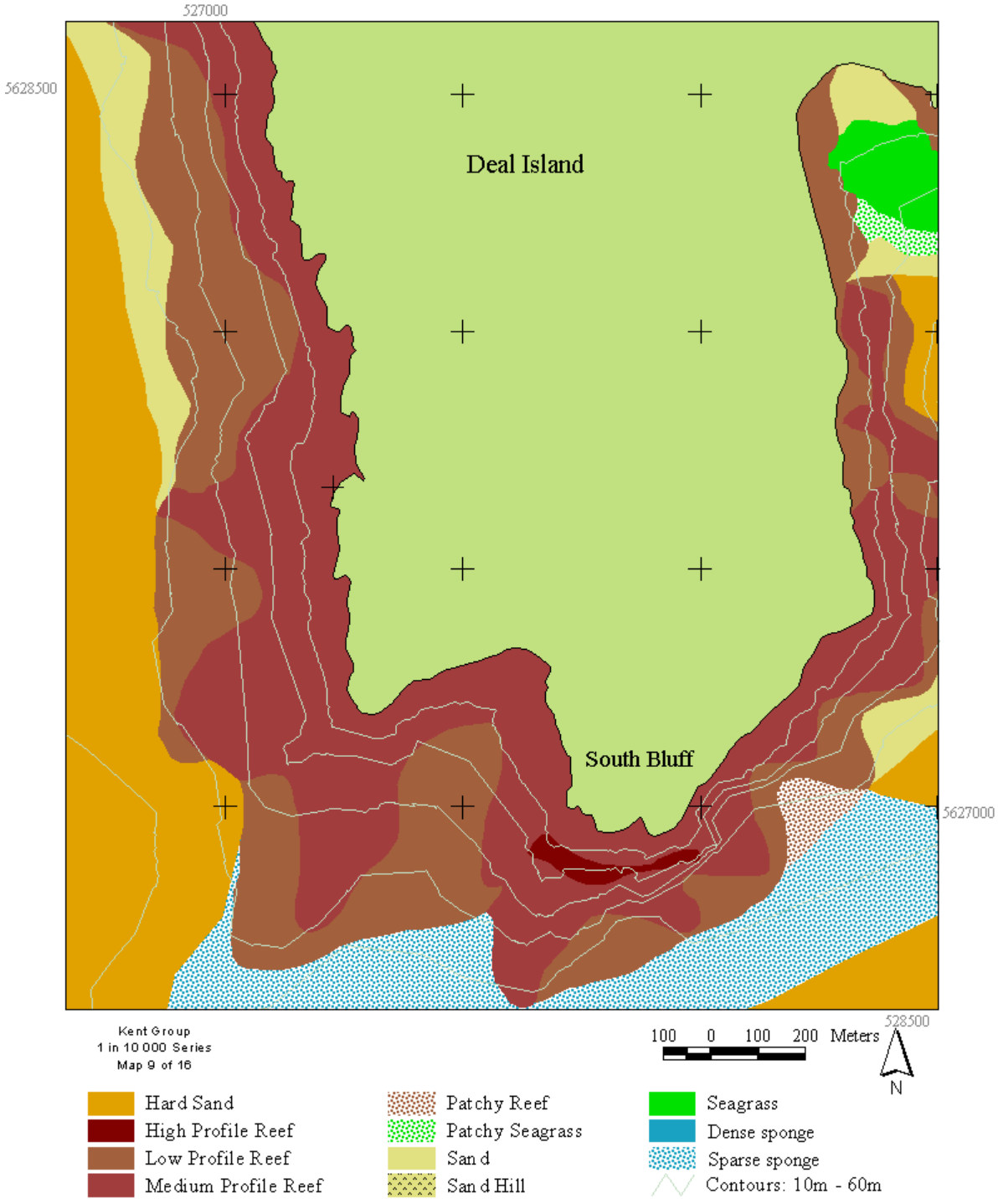

Fig. 15. Distribution of seabed habitats at 1:10,000 off south Deal Island

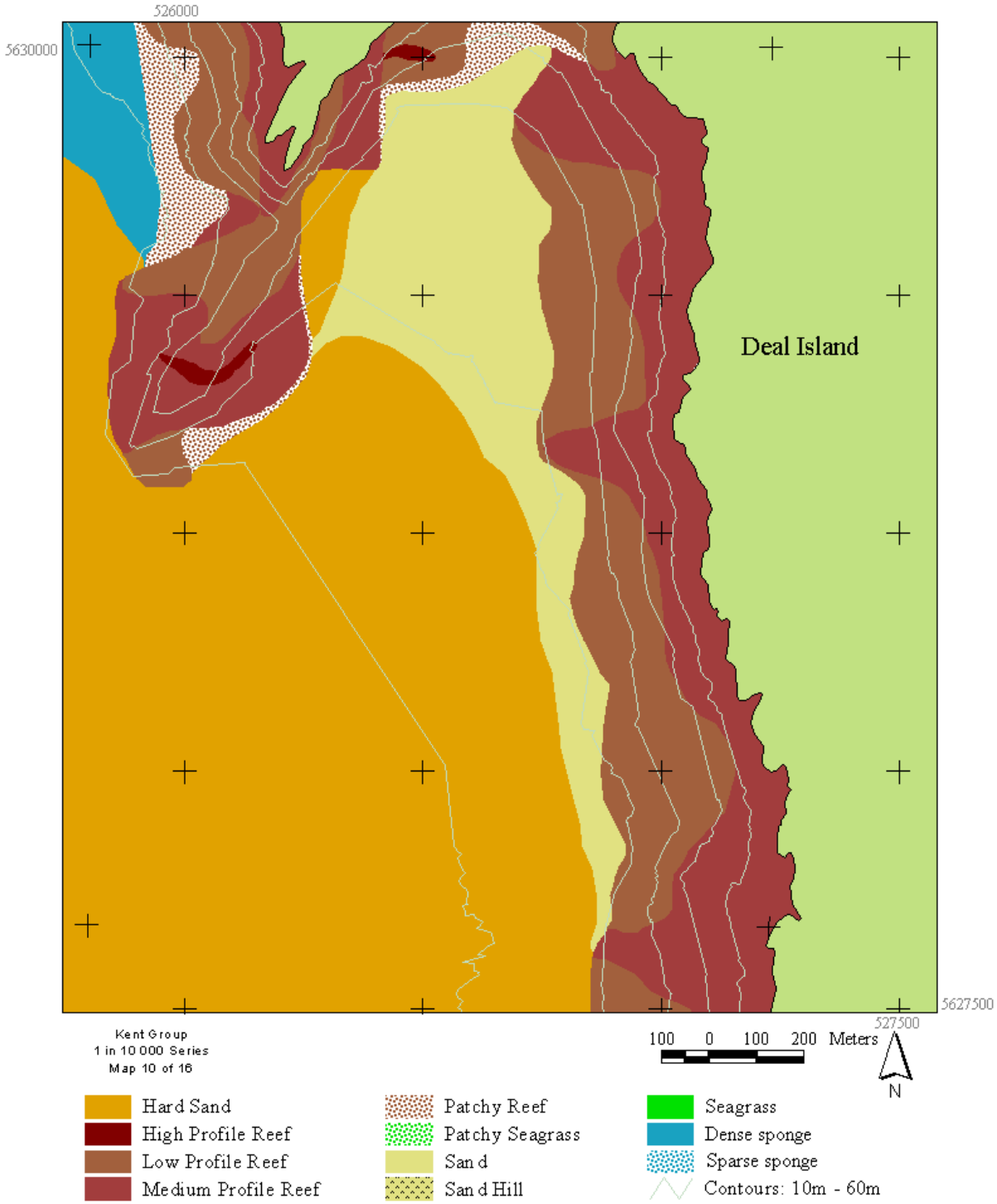

Fig. 16. Distribution of seabed habitats at 1:10,000 off south-west Deal Island

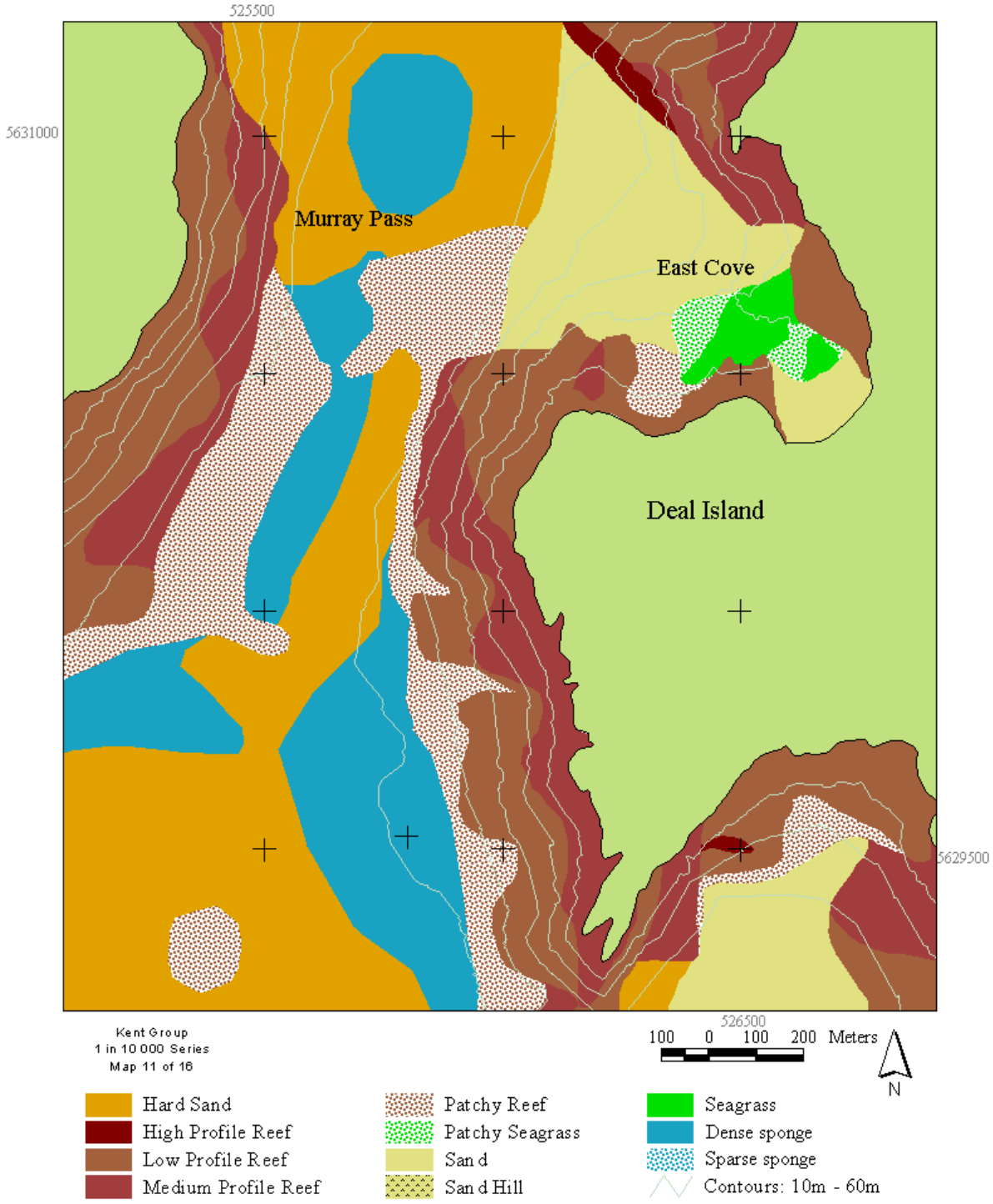

Fig. 17. Distribution of seabed habitats at 1:10,000 in southern Murray Passage

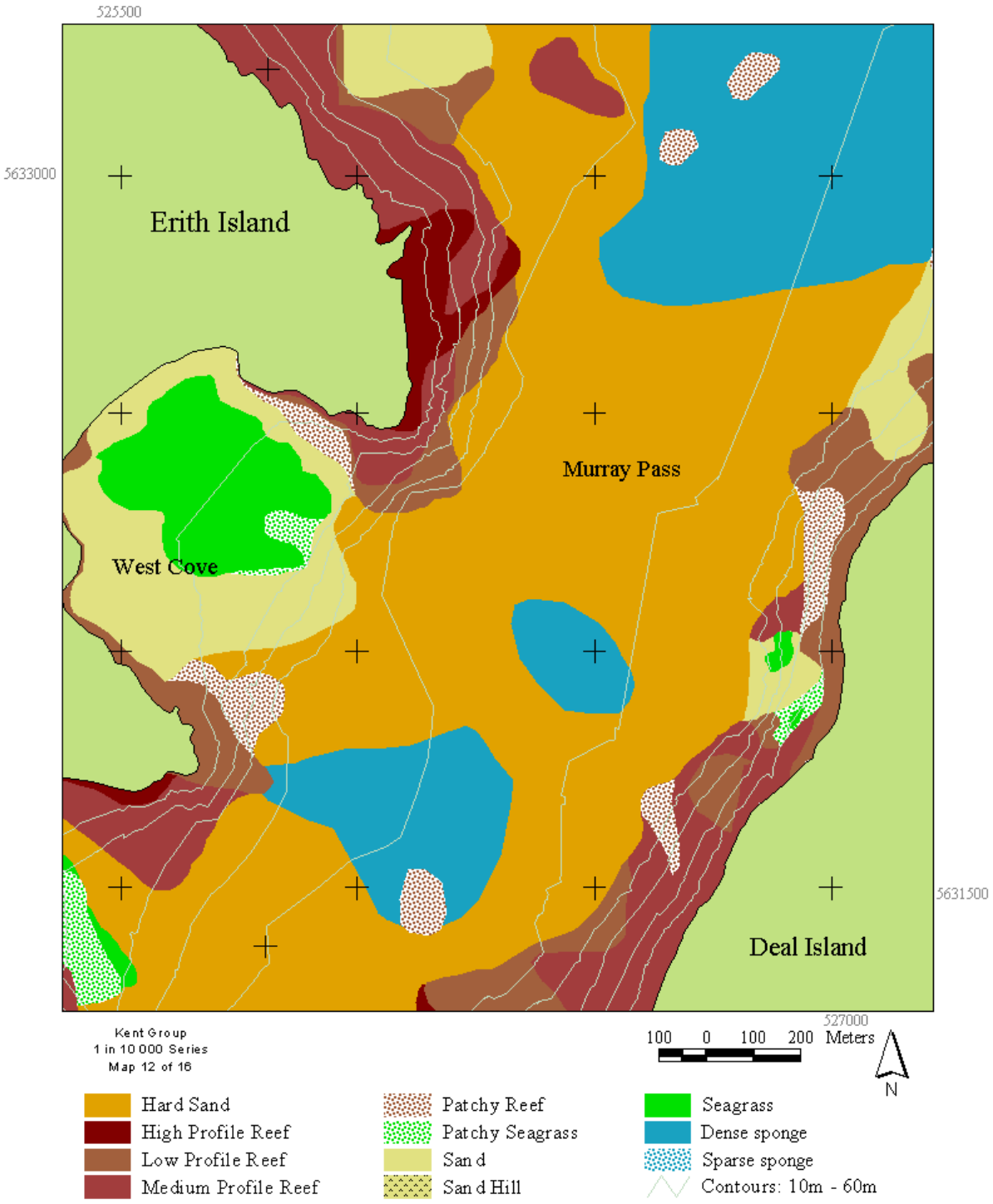

Fig. 18. Distribution of seabed habitats at 1:10,000 in northern Murray Passage

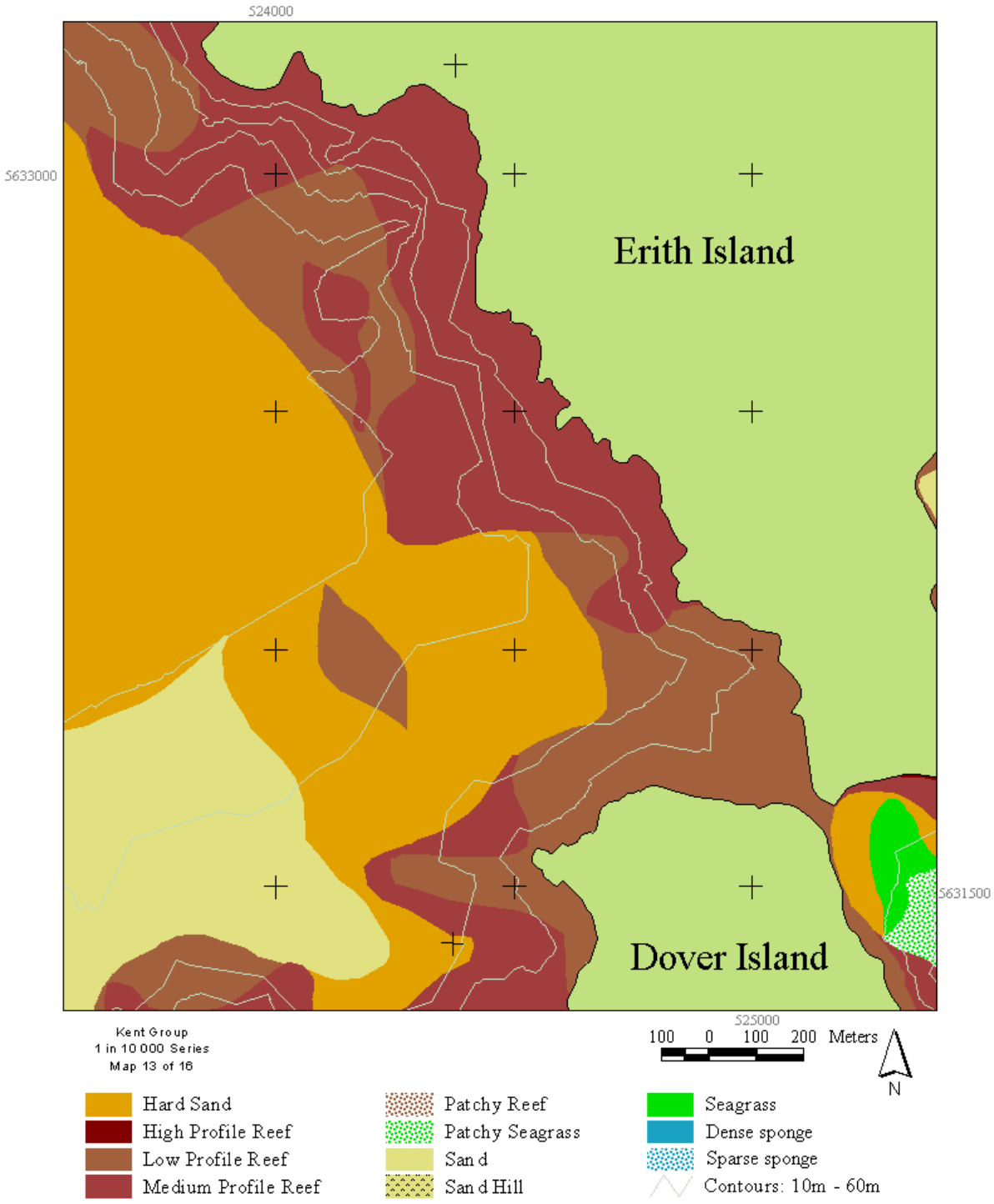

Fig. 19. Distribution of seabed habitats at 1:10,000 west of Dover and Erith Islands

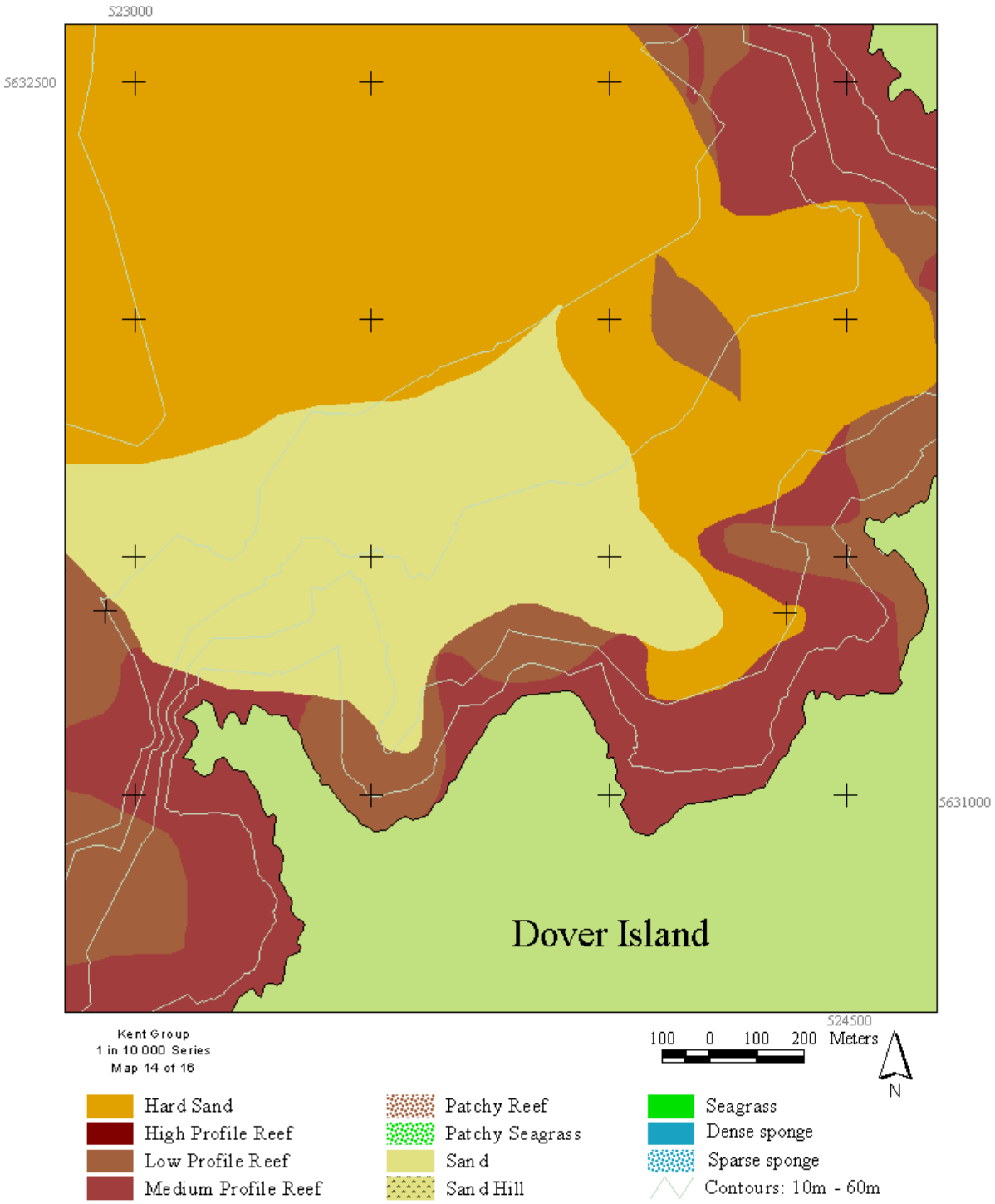

Fig. 20. Distribution of seabed habitats at 1:10,000 off west Dover Island

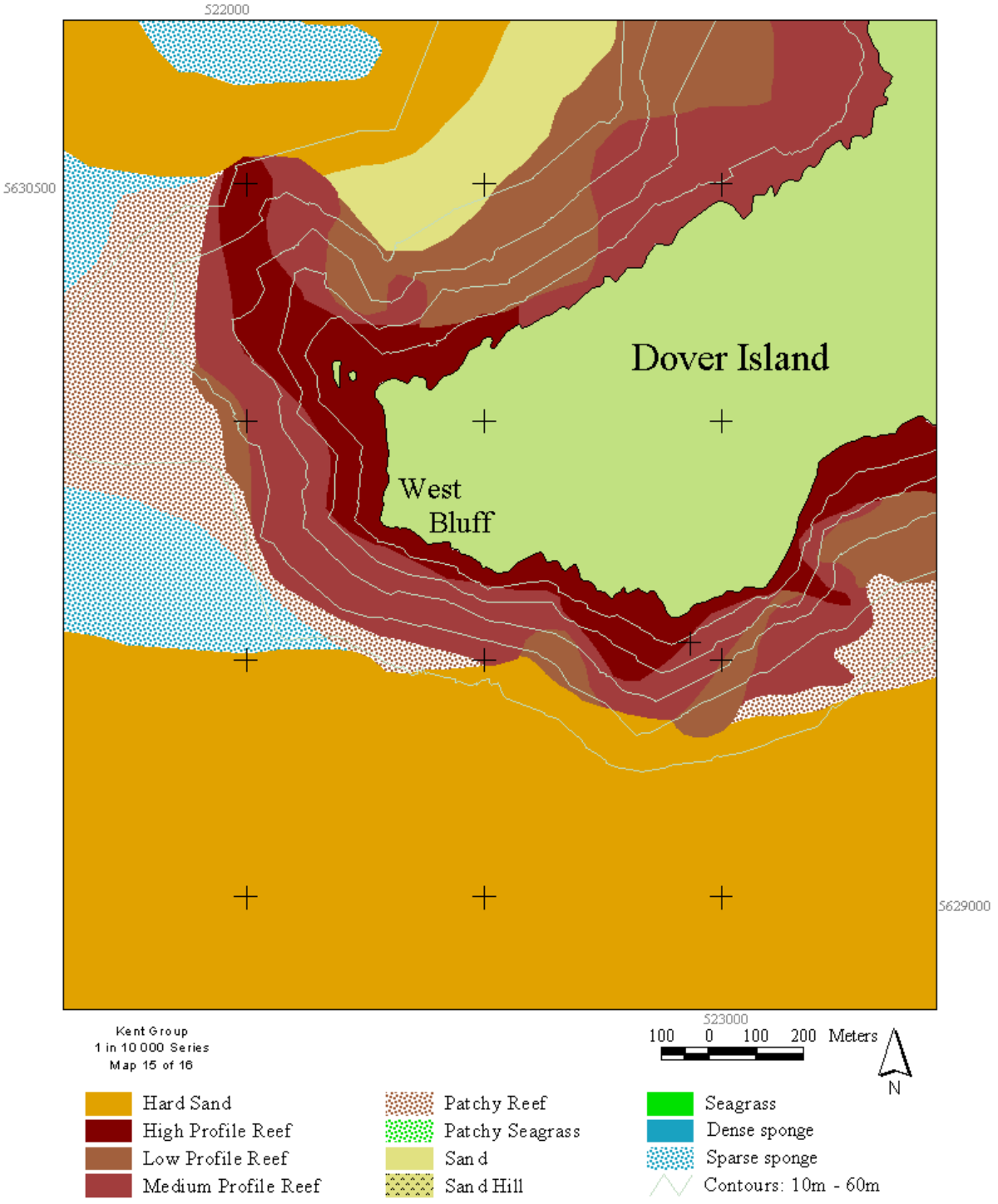

Fig. 21. Distribution of seabed habitats at 1:10,000 off south-west Dover Island

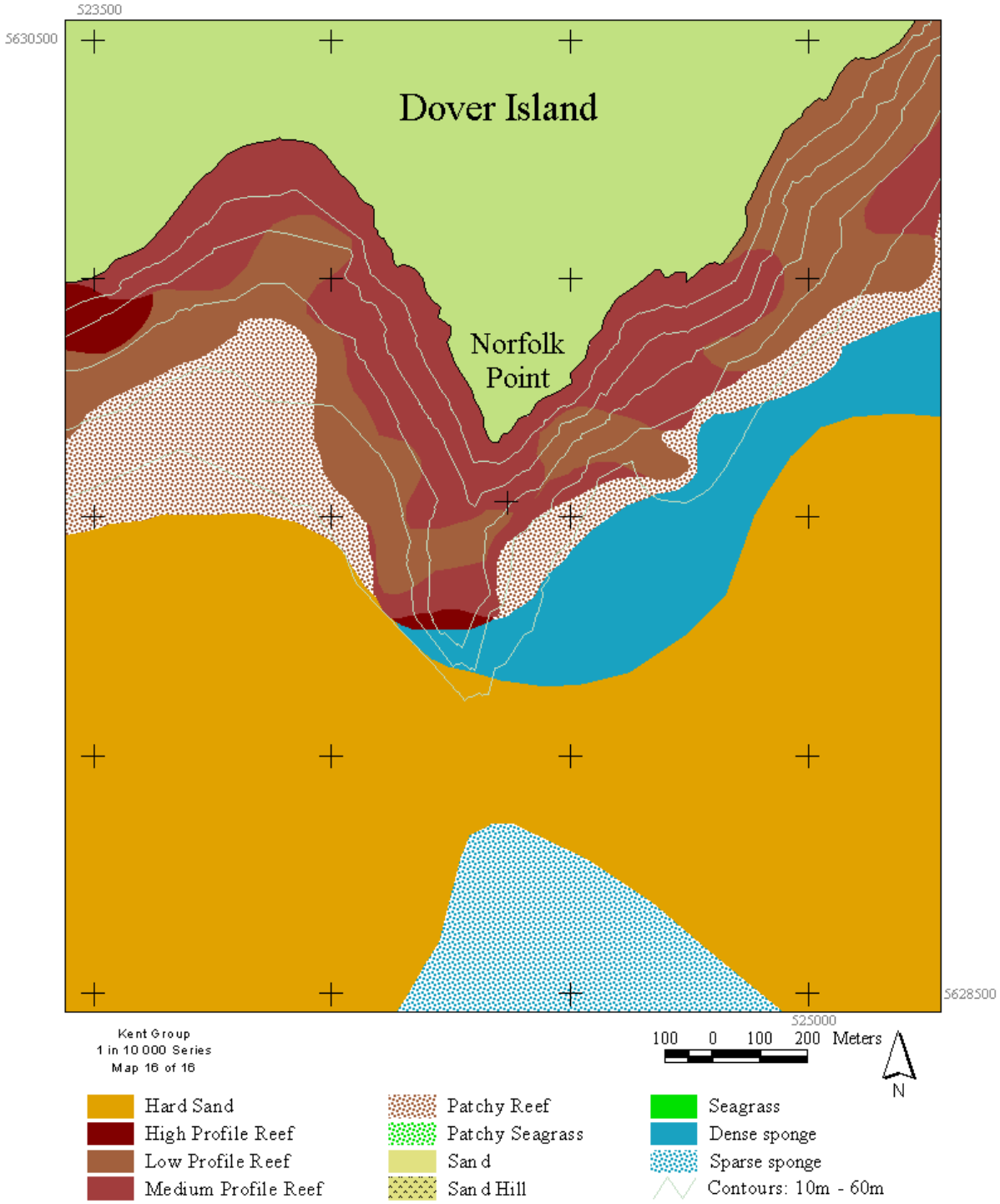

Fig. 22. Distribution of seabed habitats at 1:10,000 off south Dover Island

4. Discussion

4.1 Rocky Reef

Rocky reef was a significant habitat throughout the Kent Group of islands representing around 5% of all habitats within 3 Nm and up to 56% in depths of 0-40 m. While rocky reef occurs adjacent to most of the coast there is some variation in the degree of exposure with prevailing west to south-westerly winds giving west to south facing coasts the greatest exposure (Edgar, 1984). Due to the blocking action of Tasmania, mainland Australia and Flinders Island, the Kent Group is protected from oceanic swells from all but easterly directions. As the macroalgal assemblage present at any location is strongly influenced by the degree of exposure to swell and wave action, a description of the dominant algal species enables an understanding of exposure regimes in the absence of detailed physical data on sea-state and wave energy.

The absence of regular high-energy swells in this region is reflected in the algal assemblage, as *Durvillaea potatorum* (bull kelp), a conspicuous kelp on maximally exposed temperate coasts, was not found in the Kent Group during this or previous surveys (Edgar, 1984; Barrett and Edgar, 1992). Reefs on the exposed coasts were dominated by *Phyllospora comosa* which extends from the immediate subtidal zone to depths of 10 to 20 m where it is gradually replaced by *Ecklonia radiata*. The presence of *P. comosa* is generally indicative of a sub-maximally exposed coast, and this species is absent in locations without constant water movement, such as most of the Tasmanian north coast (Barrett and Willcox, 2001). At depths below 25 m, *Ecklonia radiata* is gradually replaced by invertebrate assemblages (most notably sponges), until approximately 40 m where it is completely replaced by invertebrates.

While there is generally one species that dominates the macroalgal assemblage at any depth there is generally a diverse range of species that are also present. Apart from those detailed earlier, the dominant species identified from previous surveys included *Cystophora moniliformis, C. monilifera, Sargassum vestitum, Xiphophora chondrophylla* and various species of *Caulerpa* (Edgar, 1984). While a survey of reef biota was not a component of this survey, the flora and fauna of reefs within the Kent Group have been described in some detail by Kuiter (1981), Last and Harris (1981), Edgar (1984), Barrett and Edgar (1992) and summarised in RPDC (2002). These studies provide sufficient information when combined with the current mapping of this area to be able to predict the dominant species in assemblages present at most inshore locations within the Group for the purposes of conservation planning.

Of particular interest is the fact that while there is a diverse range of macroalgal species in the Kent Group they are not distinct from other northeastern Bass Strait Islands (Edgar *et al*. 1997). Of the 40 seaweed species recorded in the 1992 survey, most are widespread around northern Tasmania (Barrett and Edgar, 1992).

In addition to the distribution of reef by depth and exposure, there are two characteristic habitat features of reefs within the Kent Group that influence the biotic assemblages present. The first of these is a physical characteristic, where the underwater topography is dominated

by massive granite blocks, interspersed by clefts, ledges and caverns (Edgar, 1984). The extent of complex reef structure is indicated by the extent of moderate to high complexity reef identified by this survey, and the complex habitat this structure provides is reflected in the diversity of fishes found in the Group (Barrett and Edgar, 1992).

The other characteristic feature is a biological one, and relates to urchin barrens resulting from intense grazing by the long-spined urchin, *Centrostephanus rodgersii*. Barrens were found at numerous locations where video drops were conducted, and these constitute a distinct habitat of their own within the overall depth/exposure classification of the reefs. The habitat is characterised by the almost complete absence of macroalgae, and an enhanced presence of planktivorous fish. Barrens can extend from depths of 4m to over 30m, are most characteristic of the more sheltered locations, and have been present at the Kent Group from at least 1983 when they were first reported from Murray Pass (Edgar, 1984).

4.2 Seagrass

Seagrasses are marine flowing plants that are adapted to soft-sediment habitats in coastal waters and occur extensively throughout the east and north coasts of Tasmania (Jordan *et al*., 1998, Barrett *et al*., 2001). The beds in the Kent Group of islands were found to occur in several of the large coves inside Murray Pass and Squally Cove at southern Deal Island and often extended to a depth of around 20 m. The presence of seagrass beds at these depths, particularly within Murray Pass, reflects the general clear water conditions in this region. Barrett and Edgar (1992) suggested that these deep water seagrass beds are an uncommon habitat in Tasmanian waters. However, surveys in recent years have revealed significant areas of deep seagrass beds of both *Posidonia* (Jordan *et al*., 1997) and *Heterozostera* and *Halophila* (Barrett *et al*., 2001). In some places in the Kent Group small areas of very low density *Halophila* extended out to around 40 m, reflecting its greater tolerance to low light conditions.

While *Halophila* often occurred in depths greater than that for *Posidonia* and *Heterozostera,* there was no evidence of depth structuring of the various species. Depending on the location the shallow parts of the bed could consist of any of the seagrass species. Individual beds consisted of either a single species or a combination of *Posidonia* and *Halophila* or *Heterozostera* and *Halophila*.

Seagrass beds, particularly those dominated by *Posidonia*, are extensive throughout the shallow depths (<20 m) of eastern Bass Strait, particularly along the western shore of Flinders Island, Franklin Sound and Cape Barren Island (Rees, 1993, Jordan *et al*., 1998). In these areas *Amphibolis antarctica* also commonly occurs, either as single species beds or mixed with *Posidonia*. Of particular interest is the absence of *Amphibolis* in the Kent Group of islands that has previously been identified in the area by Edgar (1984).

4.3 Sponge

Sponge habitat was found to represent around 40% of the habitats in depths greater than 40 m around the Kent Group of islands. Their distribution is likely to be determined by the availability of suitable substrate and current velocities. In general, sponge consisted of two

generally distinct habitat types. Sparse sponge consisted primarily of small clumps of low profile sponge interspersed within sand or hard sand and was common to the east and west of the islands. Dense sponge occurred primarily on consolidated substrates with a higher relief where the cover and morphological diversity was considerably higher. The habitat also often had large numbers of the ascidian *Pyura* sp. and numerous types of octocorals, anemones, soft corals and bryzoans of various growth forms. These range of invertebrate groups are commonly associated with sponges creating a distinct community of sessile filter feeders often referred to as 'sponge gardens'. These sponge habitats are an important component of temperate benthic communities, particularly in depths below the macroalgal zone and in areas of higher current speeds. The large area of dense sponge in Murray Pass reflects the presence of considerable areas of consolidated substrate in depths >40 m and high currents speeds through the Pass.

The octocorals occur as colonies attached to the seabed and can be encrusting, erect or branched. Bryzoans are colonial animals that often form large aggregations made up of numerous small (~1 mm) units called zooids (Edgar 1997). They are often form a significant part of the invertebrates in sponge communities. Ascidians are also a significant component of the sessile filter feeding community and have both colonial and solitary species. Around 210 ascidian species occur in southern Australian waters, with many species still to be described (Knott, 1997). In general, there is considerable taxonomic uncertainty in all of these groups and therefore it is not possible to compare diversity at a lower hierarchical scale than that of sparse and dense. However, as sponge morphological diversity can be used to provide a qualitative estimate of sponge species diversity (Bell and Barnes, 2001), further video analysis could provide more details on spatial diversity.

4.4 Unvegetated habitats

Unvegetated habitats are widely distributed around the Kent Group of islands and represent around 55% of all subtidal habitats within the 3 Nm limit. The dominant habitat within this category is hard sand that consisted of coarse sand approaching gravel, or sand with dead shells or shell grit. The dominance of coarse sediment in the region reflects the absence of finer coastal sediments, the islands granitic structure and strong tidal currents and oceanic swells. Much of the shell material consisted of dead scallop shells which are known to occur in patchy beds throughout eastern Bass Strait. There is a general trend of increasing hardness with depth, with an increasing proportion of hard sand with depth that can occur adjacent to either sand or reef.

Sand habitat occurred primarily in the bays on each of the three main islands of Deal, Dover and Erith, often adjacent to the deeper margin of the fringing reefs in depths from 30 to 50 m. The actual area of sand is likely to be an underestimate as it was also the dominant sediment type between the areas of patchy reef, patchy seagrass and sparse sponge. A unique feature of the seabed landscape to the west of Erith and Dover Islands are distinct sand hills that are areas of sand consolidated into calcarenite. Anecdotal evidence suggests that these hills ridges are used by rock lobsters as migratory routes in the region (Edgar, 1984).

5. Acknowledgments

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